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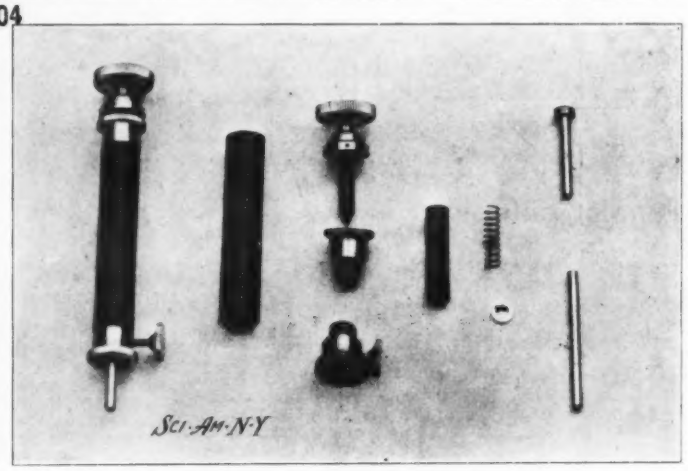
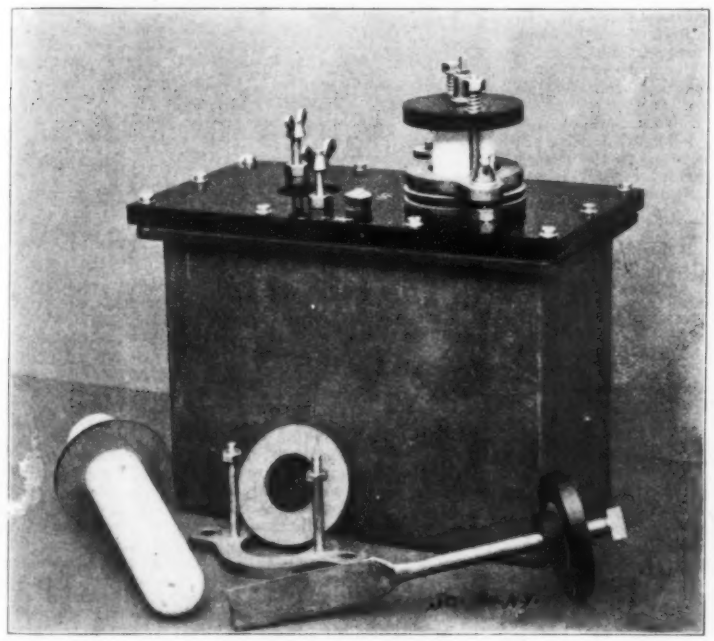
CUXHAVEN STATION.

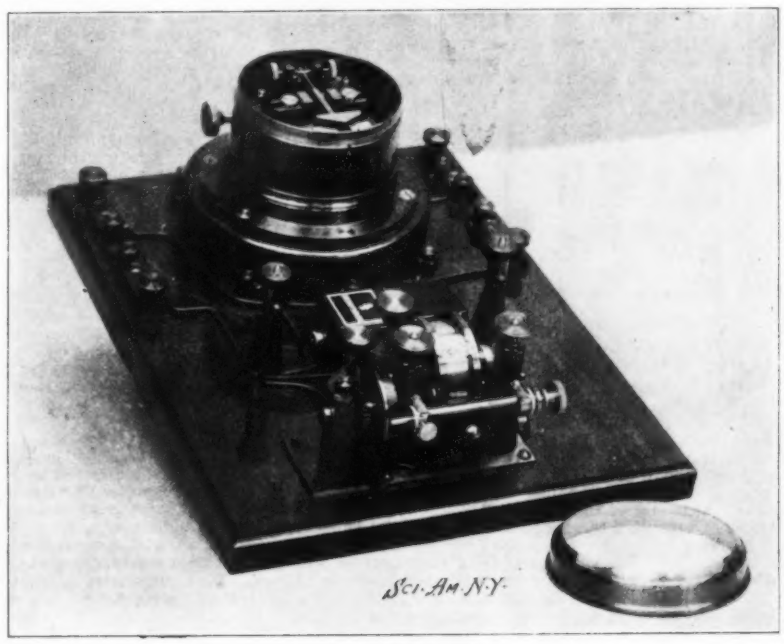
THE TRANSFORMER OF THE TRANSMITTER.



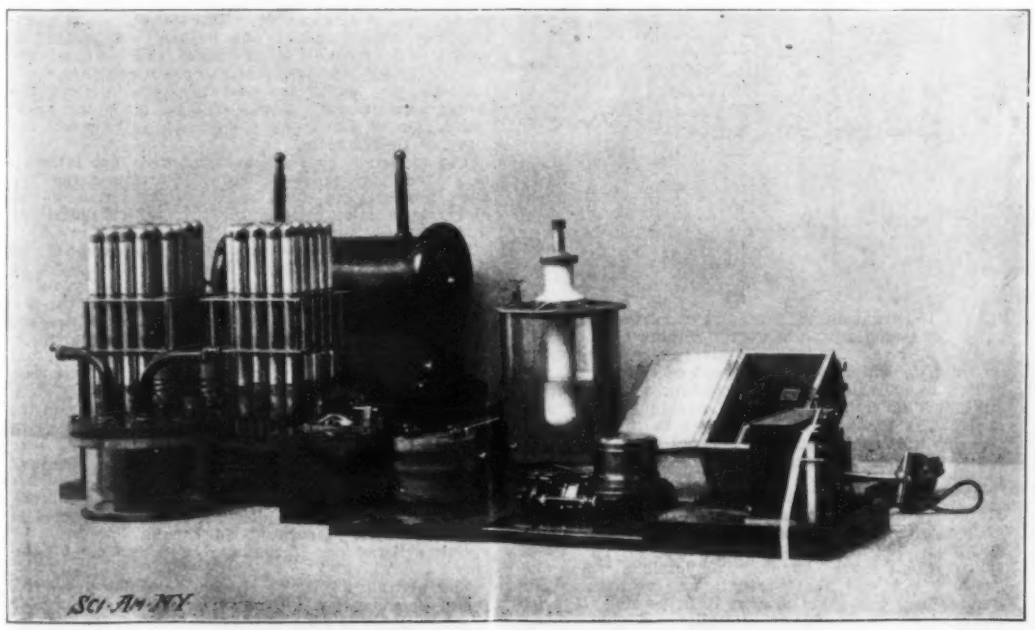
STEEL COHERER SEPARATED.



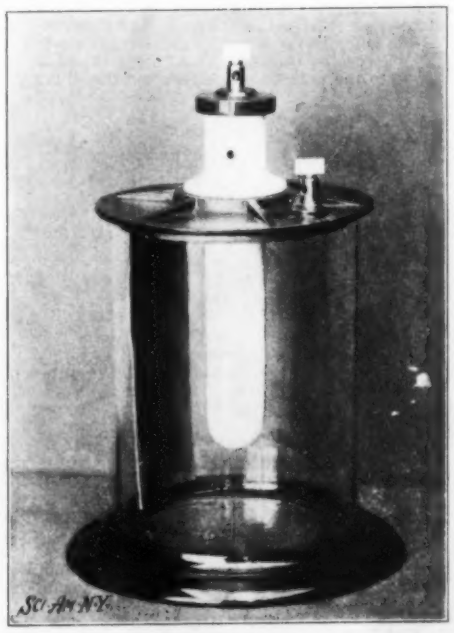
THE INTERRUPTER.



THE RECEIVER.



A COMPLETE SET OF BRAUN WIRELESS TELEGRAPH APPARATUS.



WEHNELT INTERRUPTER.

THE BRAUN-SIEMENS-HALSKE SYSTEM OF WIRELESS TELEGRAPHY.

THE BRAUN-SIEMENS-HALSKE SYSTEM OF WIRELESS TELEGRAPHY.

IT has been clearly demonstrated that a conductor in which electric vibrations are to take place must have capacity and self-induction. In wireless telegraphy, the conductor in which the vibrations are generated can be used directly as a transmitter. On the other hand, the vibrations may be generated in a special conductor connected with the transmitter. The difference between the two methods is of the greatest practical significance. The second method, which we owe to the Strasburg professor of physics, Ferdinand Braun, shows, as compared with the first, a decided advance in the technique of wireless telegraphy.

This will appear by considering how Marconi and

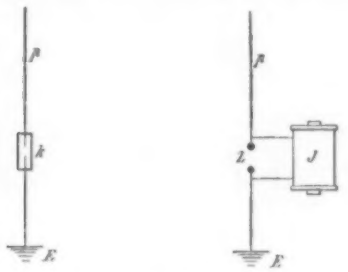


FIG. 1.

his successors proceeded at the outset. They introduced a spark-gap, z (Fig. 1), into the conductor, p, which was grounded and served as transmitter; the poles of the induction-coil, J, were placed on either side of the spark-gap. The receiver was arranged in the same simple manner, the coherer, k, being inserted between the air-wire and the wire leading into the ground. The amount of the charge depends upon the capacity of the conducting wire, which is not very great. The oscillation caused by the spark current is comparatively limited. The air-wire emits energy in electric waves and is effective in this radiation. The comparatively small quantity of electric energy quickly diminishes, and the oscillations die out rapidly. The Marconi transmitter makes the generation of oscillations possible, but they are transient. We can increase the capacity of the conductor by joining it to one end of a condenser, whose other end is grounded.

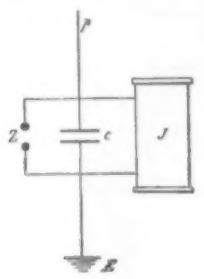


FIG. 2.

We then have the spark-gap between two poles, which is illustrated in Fig. 2. The condenser, c, can be so constructed that the number of oscillations will be in accord with that of the conductor.

Thus a new plan has been devised which is indicated by heavier lines for the essential part of the construction (Fig. 3). The spark-gap, z, the condenser, c, and the conductors which join them and which must have a certain degree of self-induction, form by themselves an oscillatory circuit of great capacity, bringing into action considerable quantities of electricity. The conductors may be short; they will meet with little resistance, and the space of radiation remains small. In such a circuit the electricity, on account of its slight dissipation, will oscillate for a long time.

Now join wire, p, which is the vertical air-wire, with one side of the condenser, its length being so proportioned to the number of oscillations* that it is a quarter

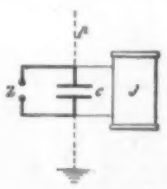


FIG. 3.

of the length of the waves, corresponding to the number of oscillations. Then electric oscillations are conducted to the wire and are formed into a constant wave, the length of the wire being calculated to produce this effect. If the wire should really not be in perfect accord with the condenser circuit, and should tend to vibrate differently, its influence would not prevail against that of the condenser current. To illustrate this, take a hundred-pound weight, fasten it to a pole and let it swing as a pendulum. By its side suspend a light wooden pendulum. Let the first have a time of vibration of one second, the other a time of vibration of a third of a second. Connect both pendulums with an elastic cord, and the light pendulum will swing in rhythm with the slow one; if the light pendulum should incline to swing in an opposite direction it will pull on the elastic cord, but this slight exercise of force will not prevail, and the oscillations of the light pendulum will correspond with those of the heavy and slow pendulum.

Prof. Braun noted the effect of using an overpowering oscillatory circuit of great capacity in connection with a subordinate oscillation conductor serving as a transmitter. His discovery proved of great importance. The following advantages have been secured. The condenser circuit can be exactly attuned to the time of vibration desired; it generates therefore only vibrations of a definite number (simple waves). By reason of its great capacity it holds a comparatively large quantity of electricity, as it does not radiate and has but a slight resistance, the electrical energy oscillating for a long time. The strong condenser current compels the feeble conductor current to follow it in its oscillations. The latter contains, therefore, supposing that its length has been measured correctly, simple waves; it receives an enduring supply of en-

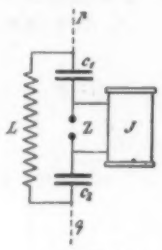


FIG. 4.

ergy, so that the conductor (transmitter) oscillates a long time.

On the application of simple, lasting and intensive waves depends the efficacy of a wireless telegraphic apparatus and its charging distance. Prof. Braun attacked the problem in the right way; and his invention materially improves the art of wireless telegraphy.

The simple condenser circuit, which we illustrate in Fig. 3 was replaced by a double one as illustrated in Fig. 4, c_1 and c_2 being two condensers or two Leyden jars. The inner coatings are separated by a spark-gap and also by the two poles of an induction coil, J. The outer coatings are joined to each other by a metallic conductor-loop, L, which has self-induction. Whenever the coil charges the inner coatings of the Leyden jar, the outer coatings are also charged. When there is an inner discharge by sparks in the spark-gap, there is also an outer discharge; the discharges oscillate and the inner and outer vibrations are in perfect accord.

The outer coatings of the two Leyden jars of the double condenser circuit are each joined to a wire of the length of a quarter wave, according to the determined number of oscillations. Each wire receives oscillating charges and a permanent quarter wave is

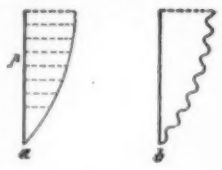


FIG. 5.

developed in it; one end is joined to the coating of the jar and the other end is free. The oscillations of the wire, as determined by its capacity and self-induction, are suppressed by the more powerful influence of the Leyden jar circuit. The distribution of the charges on the wire is not mathematically equal to a simple oscillation, as in Fig. 5, a; but the charge will be distributed in the manner shown in Fig. 5, b. It will be a subsidiary oscillation. These incidental oscillations soon die out and do not influence the larger waves.

Besides directly joining the Leyden-jar circuit to

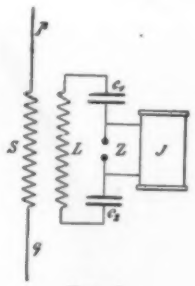


FIG. 6.

that of the transmitter, Prof. Braun makes use of an inductive transformer. Here the joining of the outer coating of the Leyden jars is equivalent to the primary winding, L, while the central part of the transmitter circuit is equivalent to the secondary winding, S, of an induction coil. Fig. 6 will explain this arrangement. The wires which are joined to the coil have the length of a quarter wave and are subjected to the same influence as when two circuits are directly joined.

The conjunction of the open and closed circuits of vibrations has another advantage. It dispenses altogether with any connection with the earth. This advantage has a double value. First, wireless telegraphy is not made difficult or impossible, where the earth is not well adapted to it, as, for instance, in mountains. With this system it is possible to send out electric waves from a balloon while soaring through the air. Secondly, the atmospheric electricity can exert no influence on the electric wire.

The receiver in the Braun system is similar to the transmitter, only that the aerial wire is connected by an inductive transformer to the circuit of the Leyden jars. Fig. 7 exhibits the arrangement. The inner coatings of the condensers, c_1 and c_2, are connected with the outer coatings by an electric circuit of which the primary coil forms part. The latter produces the required self-induction. The conductor, with one end elevated, is attached to these coatings. The secondary coil, S, is joined to conductors, p and q, each a quarter wave in length, and in one of these the coherer, K, is placed.

The elevated wire takes up the electric waves and oscillates strongly, but transmits its energy immediately to the condenser circuit; it is, therefore, never saturated and is ever ready to take up more electric energy. Of course the transmitter and condenser circuits must be attuned with regard to oscillation. The condenser circuit, which on account of its size can receive a great deal of energy, oscillates and induces in S, and conductors, p and q, similar oscillations, they all being syntonized with the oscillations. In this way much energy is taken to the coherer, and this is of prime importance.

Marconi's original construction was not attuned or syntonized; the capacity of the transmitter was small, as well as that of the receiver. Also, a considerable part of the collected energy was lost through impure waves into heat, which was not without its effect on the coherer.

In brief the Braun construction makes it possible to send out pure, strong and lasting electric waves. Wireless telegraphy is made independent of any connection with the earth, and is protected from the disturbing influences of atmospheric electricity.

Prof. Braun commenced his researches in Strasburg, where he tried his system at short distances; later, he moved his establishment to Cuxhaven, in order to continue his investigations at the mouth of the Elbe.

The firm of Siemens & Halske had also for years been engaged in extensive experiments in wireless telegraphy, which had led them to adopt a system that had been practically tested. It so happened that the two systems, that of Prof. Braun and that of Siemens & Halske, supplemented each other. The professor and the Berlin firm of electricians became associated, and thus originated the combined Braun-Siemens & Halske system. Dr. Koepsel, of the firm of Siemens & Halske, has rendered important service in applying and perfecting it.

In this combined system an electric circuit is formed by means of a primary induction coil, an interrupter, Morse key, and a battery; a make and break is produced in the circuit through the Morse key. Whenever it is closed, an intermittent current is trans-

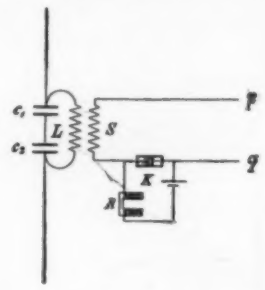


FIG. 7.

mitted to the induction coil. The latter generates a number of induced currents of short duration; of these only the stronger are of value; each of these charges the Leyden jar, until the spark appears and the charges are balanced; that is, have the same rate of oscillation. The intermittent currents pass through the primary wire of the transmitter and induce its secondary coil. From this coil the aerial wire is charged and a continuous wave is generated, producing electric waves in the wire, which radiate in all directions. Those which strike the receiver wire are taken up by it and produce electric vibrations. These are conducted to the receiver condenser circuit, from which they are transmitted to the coherer and its oscillatory circuit. The vibrations traversing the coherer cause it to close the relay circuit. In this circuit the electro-magnet of the Morse apparatus is placed; the magnet is energized and attracts the writing lever. Electric vibrations are continuous, as long as the Morse key remains closed. Thus the Morse apparatus at the receiving point, by the break into longer or shorter periods is made to represent the signs of the alphabet.

The induction coil, as constructed, is not intended to produce high tensions, but is so arranged that the secondary coil can exert only a slight action on the magnetic circuit; besides, the primary current is as little disturbing as possible.

Consequently the free tension near the ends of the secondary coil is not great, but the induction coil is especially adapted to charges of great capacity, and a time constant has been attained as small as possible; the time constant is the product of the resistance and capacity of the electric circuit. The insulation is more than double that of the ordinary type, so that the induction coil, even in damp situations, still performs its functions faultlessly.

This coil is generally joined to the Wehnelt or the Simon interrupter, both of which have proved very efficient on account of their simplicity.

Wherever only slight primary energy is required, the electrolytic interrupter is of course not required. In such cases the mercury-jet interrupter is employed. The latter, which in its effects cannot be compared to the electrolytic apparatus, is capable, however, of giving satisfaction, if managed with sufficient economy.

The platinum interrupter does not afford security for a permanent establishment, so that the Deprez or Wagner tapper is no longer recommended.

For the production of the Morse signs a special interrupter of peculiar construction has been placed in the primary electric circuit. In order to reach as high a degree of energy as in employing the electrolytic interrupter, an improvement has been effected,

* The product of length of waves and number of vibrations in the same time is constant, as is well known.

which enables it to break the circuit without injury, whenever the strength of the current reaches fifty amperes.

The oscillatory circuit consists of:

a. A system of Leyden jars. In order to secure in the smallest space the greatest and most resistant capacity, tubes have been employed, as will be seen from our picture. These tubes consist of annealed glass, 2, 5 or 3 millimeters thick and 25 millimeters in diameter. Each of them has an accurately determined capacity of 0.0004 to 0.0005 microfarad, and in case it should be broken either mechanically or by electricity, can be readily replaced by another, as is evident from the illustration.

In the lower part of the apparatus is the arrangement for the spark gap, which is surrounded by a glass cylinder.

The construction has the advantage that, without making any really important alterations in the apparatus, the capacity may be changed within the limits of 0.0002 to 0.0048 microfarad at the rate of 0.0002 microfarad. The length of the electric waves may also be changed within the widest limits.

b. A transformer. The primary coil of this is so calculated that, together with the greatest capacity, it gives the desired length of wave. The aerial wire receives about a quarter of the length of the wave.

The secondary coil is adapted to the length of the wave and does not follow the laws of other transformers, but, in connection with the conductor employed or another of the same length, must be attuned to the maximum oscillations.

As with this transformer powerful, though not dangerous, tensions occur, its coils are placed in oil.

The tensions in the receiver are not as high as those in the transmitter; therefore the condenser of its circuit may be of smaller dimensions than that of the transmitter.

The coherer used is of steel. The electrodes are also of steel, and their ends highly polished. The coherer is filled with tempered steel powder, which has been passed through a sieve. On our front page the coherer is represented with its parts disassembled.

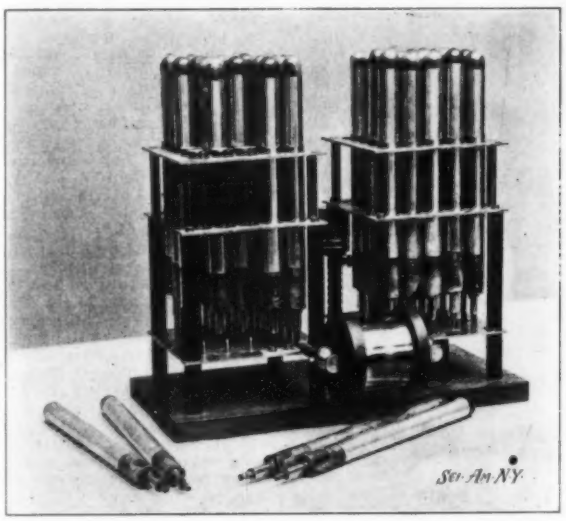
In experimenting with the steel coherer, it was discovered that it does not work accurately after the electrodes become magnetic, but that a slight degree of magnetism rather increases its excitability without impairing its reliability; a magnetic regulator was, therefore, adopted, which secures the proper condition. This consists of a permanent ring magnet, between whose poles, which are near and opposite each other, an elongated electrode of the coherer is placed. By turning the magnet ring, the north or south pole can be brought near the end of the electrode, and thus the desired degree of strength, north or south, can be obtained; or it may be demagnetized completely.

By the side of the apparatus, which is intended for the reception of dispatches by means of a writing device, a contrivance is employed which only admits of communication by telephone. This telephone receiver is about three times as sensitive as the coherer and works with accuracy. It is, of course, used only when a written record is not required.

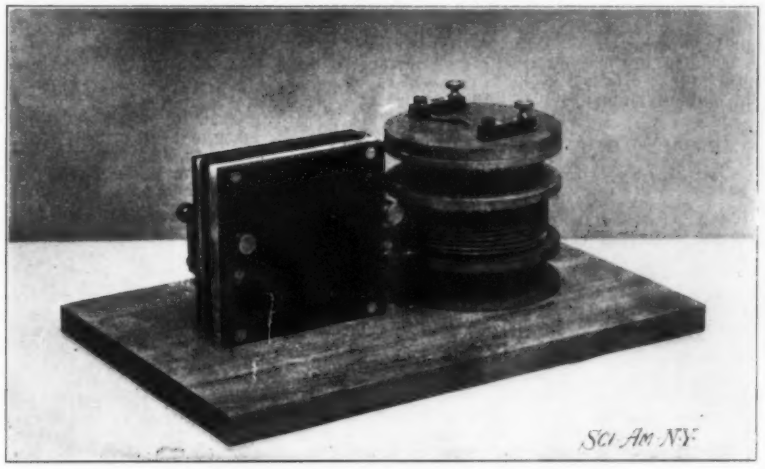
The latter apparatus consists essentially of a small hard-steel plate against which a carbon electrode (or steel electrode) ending in a point may be pressed by a micrometer screw. This contrivance is connected with a dry cell and telephone and so forms the receiver, which may be introduced in any receiver system, whether it be syntonized or not.

One of our engravings presents this apparatus, and will doubtless be understood without further explanation.

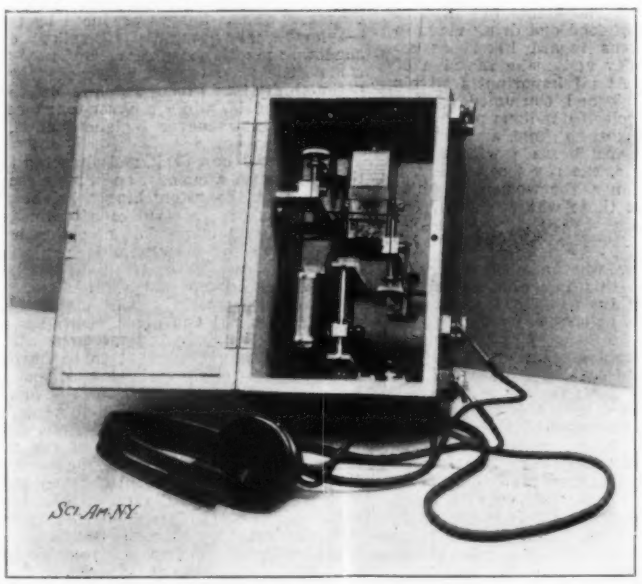
INTERIOR OF THE HELGOLAND STATION.



SYSTEM OF LEYDEN JARS OF THE TRANSMITTER.



TRANSFORMER OF THE RECEIVER.



TELEPHONE RECEIVER.

MORSE KEY.

SOME NOVEL ELECTROCHEMICAL INDUSTRIES.

THE extent to which electrochemical processes are entering the industrial field is surprising, and the directions of their development are sometimes most unexpected. It was not thought, for example, that the electric furnace would emancipate the silkworm, but such seems to be the case, according to the Electrical Review. An interesting new process has been brought out in France for the manufacture of artificial silk from the wood pulp, using electrically made carbon bisulphide as a solvent. The results obtained are most interesting and promising, and it is believed that a large outlet for carbon bisulphide will be found in this new industry. The method is extremely simple. The pulp is prepared in the usual way, as in paper-making, and is dissolved in bisulphide. The mixture is then squirted through glass nozzles of exceedingly small dimensions, issuing in fine hair-like threads, which are to all intents and purposes silk as soon as the volatile solvent has evaporated. These threads are then worked in the usual way and spun into threads for the weaving of fabrics of various kinds.

The flavor of the vanilla bean was long regarded as one of the most impossible of all natural flavorings to counterfeit. Yet to-day vanillin, which is the essential aromatic principle of the bean, is manufactured in large quantities by an electrochemical process starting with coal tar products of the anthracene series. Carbon tetrachloride, another product of the electric furnace, promises to take the place of many of the dangerous and inflammable solvents used in the extraction of grease, and in a large number of chemical industries. The field for the application of electrochemistry is so vast that it is impossible to give more than a suggestion of the opportunity it opens for development. The examples quoted above, however, show what unexpected results have already followed from the application of electricity to chemical processes.

HOW TO MAKE A DRY-CELL BATTERY.

A CONTRIBUTOR to the English Mechanic gives the following directions for making a "dry" electric battery: "First, in the construction of a dry cell we have to make the outer case; this is of thin sheet zinc. The cell may be round or square; a convenient size, easy to make, is rather under 4 inches diameter, and if a round block of wood can be found to act as a shape, much trouble will be saved. In the absence of the wood block a pint Winchester bottle may be used. Cut out as many pieces of sheet zinc as may be required, say 6½ by 11 inches; bend a piece round the bottle or shape, tie tightly in two or more places with thin iron wire, and make a neat joint with solder; then cut out a disk of zinc to fit the end, and solder it into place while still on the shape, and finally solder a short length of copper wire, No. 18, to the top of the case inside, and coil up out of the way. . . . The case is now to be lined inside with a mixture of chloride of ammonium powdered 8 ounces, plaster of Paris 16 ounces, water 8 ounces, glycerin 1½, to the thickness of about ⅜ inch, and to within ½ inch of the top. The easiest way to do this is to find another shape (which should taper slightly and be watertight); it should fit inside the cell with a uniform space of ⅜ inch or so all round. Now, having smeared this shape with oil, mix some of the plaster and chloride of ammonium, pour it into the cell, and before it has time to set press in the shape nearly to the bottom; there should be sufficient of the mixture to rise nearly to the top, and it is not difficult after the first experience to gage the quantity required. Hold the shape steady, and, when the plaster is just on the point of setting, gently rotate and raise the shape a very little, and if this is

done at the right moment, it may be withdrawn, leaving the cell with a clear and even lining. A fair quality of plaster should be chosen, neither too common nor so fine a quality as dental plaster. We now require a central carbon plate, stocked by electrical sundries men at about 3d. each for 6½ by 1¼ size with mounted terminal. The carbon plate is put centrally in the cell, and must be separated or insulated from the plaster where it rests by a piece of glass or porcelain. A supply of carbon packing may be now prepared, mixed as follows:

Gas retort carbon, finely crushed	16 ounces
Manganese peroxide, finely crushed	8 ounces
Ammonium chloride, powdered	8 ounces
Glycerin	1 ounce
Zinc chloride (commercial)	1½ ounces
Water	½ ounce

"Rub the zinc chloride in a mortar and use a little water to assist in getting a uniform pasty cream; add the glycerin, then the other ingredients, a little at a time, to get the stuff thoroughly mixed and moist throughout. Holding the carbon plate centrally in the cell, spoon some of the mixture in a little at a time and ram it down hard with a piece of stout iron rod. The stuff must be packed in hard without damaging the plaster walls; it is a good plan to line the plaster casing with a piece of stout blotting paper wetted with a saturated solution of ammonium chloride, putting this in before starting to pack. As soon as the cell is filled, we may attach a piece of wire to the carbon terminal, and test the cell by means of a bell, which it should ring loudly. To finish, the cell is filled up with melted pitch, or pitch and resin; insert a short length of glass bottle tubing, one inch, then run in the pitch. The cell is finished by giving it several coats of brown paper, put on with thin glue or shellac varnish, and a turn of corrugated paper neatly put around gives a good finish. In making a battery of these cells they should be placed in a box (the corrugated paper keeps them well apart), and coupled up in series."

MESCAL: A STUDY OF A DIVINE PLANT.*

By HAVELOCK ELLIS.

I.

MESCAL (*Anhalonium Lewinii*) belongs to the group of plants which in various parts of the world have been intimately connected with religion and have received the honors due to divine beings. This group may indeed be said to be large, but mescal—on account of the special appeal to the supernatural which its peculiar properties make—belongs to the innermost circle of such plants. It is or has been venerated by the Indians of many tribes over a very large region in Northern, Central and Eastern Mexico, in New Mexico, in Texas and in Indian Territory, each tribe having its own name for the plant—mescal, hikori, peyote, kamaba, etc.† Botanically it is a cactus, belonging to the special and little known group of Molecacteæ; there are in the group some six or seven Anahalonia; they all grow in inaccessible spots on high and rocky peaks, and have only in recent years become known to science. The plant most nearly allied to the *Anhalonium Lewinii* is the *A. Williamsii*, from which is obtained the alkaloid pellotin, lately found of therapeutic value as a hypnotic. Mescal buttons (as from their shape the dried tops of *A. Lewinii* are locally known) are somewhat brittle disks some two or three centimeters in diameter and partially covered by a hairy cushion. Lewin and Henning in 1885 first described this cactus and made experiments on animals with it, from which Lewin concluded that it is "intensely poisonous," resembling strychnine in its action, and by its lethal action standing apart from all other *Cactew*. This opinion probably rendered investigators of mescal cautious, and little further progress was made in our knowledge until 1894, when Mr. John Mooney, agent among the Indians, who had read a paper on this subject before the Washington Anthropological Society three years earlier, brought to the United States Bureau of Ethnology a large supply of mescal buttons which were entrusted to Prof. Prentiss and Dr. Morgan, of Columbian University, for physiological investigation.

II.

At this point it may be interesting to consider briefly the sacred rites with which the Indians have surrounded the mescal plant. These rites have been vaguely known for a very long time and were referred to by early travelers, like Hernandez and Sahagun. Father Ortega, on account of its hallucinatory properties, named it *Raiz diabolica* (devil's root).

The first reliable account of its use in modern times was given by Mr. Mooney from his experience of the Kiowa Indians on the Kiowa Reservation in Indian Territory. The religious ceremonies of these Indians usually take place on Saturday night; the men, having obtained a supply of the drug which is brought by traders from Mexico, seat themselves in a circle round a large camp fire within the tent. After prayer, the leader hands each man four buttons. One of these, freed from the tuft of hairs, is put into the mouth, thoroughly softened, ejected into the palm of the hand, rolled into a bolus and swallowed. Ten or twelve buttons are thus taken at intervals between sundown and 3 A. M., with the accompaniment of occasional prayers and rites. Throughout the ceremony the camp-fire is kept burning brightly and attendants maintain a continual beating of drums. The Indians sit quietly throughout, from sundown to noon of the next day, and as the effect wears off they get up and go about their work, without experiencing depression or unpleasant after-effects. On the day following they abstain, from ritual reasons, from using salt with their food. These and similar rites have become the chief religion of the tribes of the southern plain, to such an extent that the Christian missionaries, unable to grapple with the mescal cult by spiritual weapons, fell back on the secular arm and induced the government authorities at Washington to prohibit mescal under severe penalties. Nevertheless its use still persists.

Although the propaganda of the mescal cult among the Indians of the United States has thus been highly successful, it is fairly clear that much of its primitive religious significance has here been lost. We may understand how this is when we know that the Kiowa Indians are immigrants from the south; they come from the Rio Grande, and it is from the Rio Grande that they still obtain their mescal. Mexico is the chief home alike of the mescal plant and of the mescal rites in their primitive purity. It is to Mexico that we have to turn to realize their primitive significance.

As used by the Indans of the Nayarit Sierra in the province of Xalisco, mescal (or peyote, as it is here commonly called) has been described by Diguet.* Mescal is regarded by these Indians as a food of even higher order than maize, for while maize is merely the food of the body, mescal is the food of the soul. It is indeed the supreme food, and on that account is offered to the gods. Like maize, mescal has tutelary deities and a special goddess. Its psychic manifestations are considered a supernatural grace bringing man into relation with the gods; while in moderation it enables man to face the greatest fatigues and to bear hunger and thirst for five days, that is during the fast prescribed by the laws of Majakuagy. It is said that when Majakuagy was engaged in preaching his doctrines he and his disciples had to flee from persecution. In the course of his flight he broke his food vessels near San Luis Potosi, and the gods in mercy changed the fragments into mescal. The Indians only gather it in October, just before the dry season; it is said that it is only at this time that it contains its active properties. The third maize feast, which takes place at the beginning of October, is regarded as a prelude to the mescal festival and dances. An expedition is organized to the spot near San Luis Potosi, where the prophet's utensils were transformed into mescal, to gather the sacred plant. This expedition takes a month; those who lead it march in front, reciting or chanting prayers; the others follow with the pack-animals and carry the harvest. A few days before reaching the holy spot the members of the expedition practise a rigorous fast. They also perform a sort of public penance with expiation. As they return, there is great rejoicing in all the villages through which they pass, and mescal is offered on the altars and fragments given to every person met. Sufficient is reserved for the great festivals, and the rest is sold to those who took no part in the expedition.

The Huichol Indians, who occupy part of the territory covered by Diguet's investigations, have been carefully investigated as regards their religious symbolism by Dr. Lumholtz, who touches on the mescal (or, as it is here called, hikuli) cult.† He states that the expedition to obtain the plant goes to a place near the mining town of Real Catorce in October, but that the great festival only takes place in January. Abstinence from sexual intercourse is part of the cult, and it is noted that the use of the plant temporarily removes all sexual desire. The balance of the body is said to be maintained better than usual, and under its influence men walk fearlessly on the edge of precipices, and endure hunger, thirst and fatigue to an incredible extent. Lumholtz states that the festival is connected with the god of fire. We may account for this by the luminous nature of the visions caused by mescal and by the influence of a blazing fire in stimulating those visions.

The same author, in the course of an account of "Tarahumari Dances and Plant-Worship"‡ has described the cult of mescal among an allied Indian tribe who call it hikori and worship it as a god. This account furnishes a few supplementary details to Diguet's narrative of the expedition. We are told that as the Indians approach the plants they display every sign of veneration, uncovering their heads. Before gathering them they cense themselves with copal incense. They dig out the cactus with great care, so as not to hurt it, and women and boys are not allowed to approach the god. The plants are kept in jars in caves, and offerings of food and drink made to them. Even Chiutian Indians regard hikori as coequal with their own divinity and make the sign of the cross in its presence. At all important festivals hikori is made into a drink and consumed by the medicine men, and certain selected Indians partake of it, singing invocations to hikori to grant a "beautiful intoxication." A rasping noise is made with sticks, while men and women dance, the sexes separately, a picturesque and fantastic dance, the women in white petticoats and tunics, before those who are under the influence of the god.

III.

We have now to consider what are those special virtues which have caused this insignificant cactus, hidden away among almost inaccessible rocks, to be surrounded by so splendid a halo of veneration.

The first really scientific attempt to ascertain the nature of the peculiar effects of this drug on the human organism was made by Prof. Prentiss and Dr. Morgan in their investigation, already mentioned,§ of the mescal buttons obtained by Mr. Mooney among the Kiowa Indians. These observers administered the drug, in what I should consider extremely large doses (in one case as many as seven buttons), to several subjects whose symptoms were noted and their color visions briefly described. These investigators made no observations on themselves. In the following year, however, Dr. Weir Mitchell, attracted by their account of the effect of the drug, obtained some of the extract from them and made an experiment on himself, taking a large dose. Dr. Weir Mitchell describes himself as a good subject for visions and his vivid and elaborate account of his experiences, as read before the American Neurological Society,‖ furnished the first really full and instructive description of the artificial paradise of mescal. In the early part of the next year, having been greatly interested by Dr. Weir Mitchell's experience, and thinking that this drug might help to throw light on various matters which I was trying to account for, I succeeded in obtaining a supply of mescal buttons in England and experimented on myself. As these observations, the first made outside America on the psychic effects of mescal, covered the same ground as Dr. Weir Mitchell's, while at the same time revealing new classes of phenomena which had not been noted by previous observers, it may be worth while to record them in full, as fairly typical of those vision-producing properties which procured for this plant its divine honors.*

The experiment took place on Good Friday, 1897, when I was entirely alone in quiet chambers in the Temple, the most peaceful spot in central London. I made a double infusion or decoction of three mescal buttons (a single infusion is inert) and drank this, in three doses, at intervals of an hour, beginning at 2.30 P. M., two hours after a light lunch. I had not touched alcohol or smoked during the day. The following notes are reproduced, with trifling omissions, exactly as written, during the course of the experiment.

"The most noteworthy, almost immediate, result of the first dose was that a headache which for some hours had shown a tendency to aggravation was somewhat relieved. At 3 began to feel drowsy. At 3.30 took another third of the infusion. My headache was speedily still further lightened, and I now felt a certain consciousness of energy and intellectual power. No color or other visual phenomena appeared, however, even when eyes were closed for several minutes. No obvious increase of knee-jerk, though I seemed to be conscious of a certain heightening of muscular irritability as when one has been without sleep for an unusual time. Some gastric discomfort now made itself felt, but was relieved (at 4 o'clock) by eating a few biscuits. At this time, for the first time, there was a distinct lowering of pulse by some 6 or 8 beats. At 4.30 took the remaining portion of the infusion. At this period, except for a very slight frontal headache and a faint sensation of nausea, no abnormal phenomena had yet appeared, and I was feeling on the whole better than before I began the experiment. At 5 I felt slightly faint, so that it was difficult to concentrate my attention while reading, and I lay down on a couch; the pulse was still lower (48), but no visual phenomena could be detected. At 5.45 while lying down reading I noticed (what Dr. Weir Mitchell noticed) that a pale violet shadow floated over the page around the point on which my eyes were fixed. Some little time earlier I had noticed that objects not in the direct line of vision, such as my hand holding the book, frequently tended to become obtrusive, and as it were, heightened in color, monstrous and enlarged. At 6 the prevailing feeling was one of slight faintness with some muscular unsteadiness; there was no marked discomfort (except slight nausea); the headache had almost gone. No further visual phenomena except that it seemed that on closing the eyes after-images were marked and persistent. It may also be said that for some time previously, although no color visions came, the play of light and shade always seemed with closed eyes more marked than usual, and *suggested* pictures which were not really seen.

"6.15. I should take more buttons in solid form, but refrain from doing so in consequence of the faintness which makes me disinclined to do more than make these notes. Also the thought of taking more of the drug and the sight of the glass produces a feeling of nausea. The blue-black color of the ink as I write seems unusually brilliant and the shadows on my left on the verge of the visual field seem unusually violet.

"6.40. Pulse now, lying down, is about 60. When lying with eyes closed I am more conscious than before of visions on the curtain of the eyelid; but they are vague and confused, the whole of the field seeming crowded with them, and even when definite images are seen they are not recognizable, but are of the same character as the images produced by the kaleidoscope—symmetrical groupings of spiked objects. Violet shadows are still conspicuous, and now also I see what some little time earlier I seemed faintly to see—occasional distinct green shadows on the outskirts of the visual field, while a green-toned newspaper lying on the floor, whenever I glanced at it, always seems unusually green.

"7.00. It is now dark, and chancing to glance out at the window for a moment and then close my eyes I was surprised at the astonishingly bright vision of light left in my eyes, a positive after-image. All objects seen not in the direct line of vision have a tendency to look startlingly large and prominent.

"Before 7.30, when lying with closed eyes, the visions had become much distincter, but still quite indescribable, mostly a vast field of golden jewels studded with red and green stones and ever changing and full of delight. And moreover all the air round me seemed at one moment to be flushed with vague perfume—producing with the visions a delicious effect. All feelings of discomfort have now quite vanished, except only a slight feeling of faintness showing itself by tremors in hands, etc.

"8.00. The chief character of the visions is their indescribableness; sometimes, however, they are like clusters of jewels—some bright and sparkling, others with a dull rich brilliance. Again they resemble a vast collection of the glistering, iridescent, fibrous wings of gorgeous insects. But the main impression is that they are constantly approaching and constantly eluding the semblance of known things. The human face is the only known form that is sometimes momentarily caught, or perhaps merely suggested.

"8.30. [Written with pencil.] Pulse now much higher (72 in sitting position). Muscular incoordina-

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* Popular Science Monthly.

† I retain the name mescal by which the plant first became known. It has, however, the disadvantage of being identical with the name of an intoxicating drink, prepared from one or more species of Agave, with which it has no connection whatever.

* Léon Diguet, Nouvelles archives des missions scientifiques, vol. ix., 1899, pp. 621-685.

† Carl Lumholtz, Memoirs of the American Museum of Natural History, vol. iii., Anthropology, ii., 1900.

‡ Scribner's Magazine, October, 1894.

§ Therapeutic Gazette, September 16, 1895.

‖ Reprinted in the British Medical Journal, December 5, 1896.

* I published a somewhat briefer account of this experiment in "Mescal: a New Artificial Paradise," Contemporary Review, January, 1898. This paper also contains the interesting results of an experiment on an artist friend; further remarks were published in "A Note on Mescal Intoxication," Lancet, June 5, 1897. These papers attracted the attention of Dr. Walter Dixon, who made many experiments on himself and has published the results in an interesting article in the Journal of Physiology, September, 1899.

tion is so considerable that it is very difficult to use a pen, but still easy to write with a pencil.

"I find that it is easily possible to see the visions when lying down in a dark room with open eyes. (Weir Mitchell could not do this.) Sometimes the vision seems to be of a vast hollow vessel into the polished interior of which one gazes while the hue rapidly changes on its mother-of-pearl surface. The objects seen are very often extremely definite; the remarkable point is that they are always novel. There has been all along apparent hyperæsthesia to all sensory impressions.

"9.10. I had to break off as I cannot write for long at a time. The visions continue as brilliantly as ever: I think I see them better in a room lighted by fire than in a dark room. I have seen thick glorious fields of jewels which spring into forms like flowers beneath my view and then seem to turn into gorgeous butterfly-like forms. When I speak my voice seems strange to me and certainly sounds hoarse.

"As I write (by electric light) vague thin color washes seem to lie on the paper, especially a golden yellow, and even the pencil seems to make somewhat golden-tinged marks. My hands seen in indirect vision seem strange, bronzed, scaled, flushed with red. Except for slight nausea I am feeling well, my head perfectly well, though when watching the visions I once noticed slight right frontal pain. The chief inconvenience is decidedly the motor incoordination. It involves inability to fix attention long; but otherwise intellect is perfectly clear.

"9.40. [Written with pen.] I am now going to bed. Visions continue; I feel well, except for slight nausea when I move and the motor weakness. [What follows was written on the next morning.] Before going to bed I drank some hot water with a little wine in it, but took nothing to eat. On undressing I was struck by the red, scaly, bronzed or pigmented appearance of my feet, hands and limbs when I was not directly looking at them. After going to bed the nausea entirely disappeared, not to reappear, and except for thoracic oppression and occasional sighing there was no discomfort. But there was not the slightest drowsiness. I think, however that the visions might easily have blended into dream visions but that I was kept awake by a certain consciousness of faintness and by auditory hyperæsthesia. I was keenly receptive—as I had been all along—to sounds and whenever I seemed about to fall asleep I was startled either by the exaggerated reverberation in my head of some distant street sound or else by the mental image (not hallucination) of a loud sound. At a later stage there was some ringing in the ear. There were also some slight twitchings of the larger muscles of the limbs. Before going to bed I had ascertained that there was marked exaggeration of the knee-jerk, and the pupils were dilated. I felt hot; the skin was dry, the kidneys active.

"Meanwhile the visions continued with but little diminution of brilliancy, and the same perpetual novelty. Some new kind of effect was perpetually appearing in the field of vision; sometimes there was swift movement, sometimes dull somber richness of color, sometimes glitter and sparkle, once a startling rush of flashes that seemed to approach me. Usually there was a combination of rich dark color with jewel-like spots of brilliant color. Every conceivable color and tint seemed to appear at one time or another (Weir Mitchell never saw blue). Sometimes the different varieties of one color, as of red, would spring up in turn—scarlet, crimson, pink, etc. But, in spite of the immense profusion of objects, there was always a certain parsimony and æsthetic value in the colors presented. They were always associated with form, and seldom appeared in large masses of color; if they did the color was of very delicate tone. I was struck not only by the brilliancy, delicacy and variety of the colors, but by the great variety and loveliness of texture which they presented —fibrous, waxen, polished, dull, glowing, veined, semi-transparent, etc. The glowing (jewel-like) and the fibrous (insect-wing) textures were perhaps the most prevalent. Although the effects were novel, they often vaguely recalled known objects—exquisite porcelain, elaborate sweetmeats, Maori architecture, Moorish windows. But in all these cases the objects grew and changed beneath my gaze without any reference to the characteristics of those real things of which they vaguely reminded me. I tried to influence their course, but with very little success. It seemed that colors could to some extent be called forth, but I could not evoke the simplest image by an act of will.

"On the whole, if I described the visions in one word, I should say that they were living arabesques. There was generally a certain incomplete tendency to symmetry, the effect being somewhat as if the underlying mechanism consisted of a large number of polished facets acting as mirrors. It constantly happened that the same image was repeated over a large part of the field, though this holds good mainly of the forms, for in the colors there would still remain all sorts of delicious varieties. Thus at a moment when uniformly jeweled flowers seemed to be springing up and extending all over the field of vision, the flowers still showed every variety of delicate tone and tint.

"Unlike Weir Mitchell, who could not see the visions with open eyes even in the darkest room, I could see them in the dark with almost equal facility when my eyes were open, though they were not of equal brilliancy. After observing them in the dark for some hours, I became a little tired of them and turned on the gas. I then found that I was able to study a new aspect of these visual phenomena. The gas jet (a common flickering burner) seemed to burn with great brilliance, sending out waves of light which expanded and contracted enormously. I was even more impressed by the shadows which were in all directions heightened by flushes of red, green and especially violet. The whole place became vivid and beautiful and the tone and texture of the whitewashed but not very white ceiling was immensely improved. The difference between the room as I saw it then and the appearance it usually presents was the difference one may often observe between the picture of a room and actual room. The shadows I saw were the shadows that the artist put in, and that are not visible in the actual object under ordinary conditions of casual inspection. At the same time shadows chased each other across the walls, never becoming actual visions.

"I wished to ascertain how the subdued and steady electric light could influence the phenomena, and passed into the next room. Here the rich shadows which were evidently largely due to the stimulus of the flickering light were not obtrusive. But I observed that whatever I gazed at seemed to show a tendency to wave or pulsate. If I looked at the matting on the floor it showed a singular richness of texture, thick and felted, with a tendency to rise in little waves. These effects were apparently due to the play of heightened shadows on the outskirts of the visual field. In the same way a closed door seemed to be ajar, from the heightening of the shadows in the interspaces.

"I returned to bed still experiencing the same phenomena, though in a less degree, and now for the first time there was a tendency for human figures to appear, fantastic and Chinese in character. There were vague hallucinations of smell, sometimes distinct recurrence of the freshly prepared mescal infusion; these olfactory impressions were pleasurable, I think because they involved deep inspirations, and thus relieved the respiratory oppression.

"At 3.30 A. M. I felt that the phenomena were diminishing and was able to settle down to sleep. When I awoke two hours later, after a peaceful and dreamless sleep, there was a slight headache and the visions were still present with closed eyes, though they were now in somber colors, brown and black. I slept again for an hour or so and rose at the usual time feeling by no means tired, and with an excellent appetite; except for a slight headache, which passed off in the course of the morning, I felt none the worse but rather the better for my experiment. The only after-effect was a slightly hyperæsthetic vision for colored objects (as at the beginning of the experiment), lasting for a day or so, and more especially noticeable as regards blue, so that a familiar notice-board in the Strand with dark-blue background was much more conspicuous and intensely blue than usual."

(To be continued.)

VOLCANOES.*

EONS ago the earth on which we live was a huge mass of "fire mist." Astronomers tell us that to-day in the heavens we can see vast nebula, suggesting what the earth was once. Gradually the surface of the "fire mist" cooled and hardened, but the interior is still intensely hot. Whether it is solid, liquid, or viscous we do not know. This heat, raging miles below the surface, at times escapes through the hard crusts by vents or volcanoes.

There are from 300 to 360 volcanoes on the globe. This estimate includes merely live volcanoes and volcanoes which within recent times have been in action. If we should count the many mountains scattered over the earth which show to-day signs of volcanic action in more remote past the estimate would have to be increased by many hundreds.

Volcanoes would seem to be arranged with more or less symmetry in belts circling the great oceans. A ring of fire surrounds the Pacific. Starting at the South Shetland Islands, several hundred miles south of Cape Horn, a belt of volcanoes extends up the west coast of South America, Central America, and North America; from Alaska it crosses the Pacific along the Aleutian Islands to Kamchatka; thence it follows the east edge of the Pacific through the Kurile Islands, Japan, Formosa, the Philippines, the Moluccas, the Solomon Islands, the North Hebrides, New Zealand, and finally ends in Mounts Terror and Erebus, on the Antarctic Continent. The volcanoes forming this great belt are in places ranged in chains, as along the west coast of Central America and in the Aleutian Islands; elsewhere they are separated by long distances, but nevertheless they would seem to have some connection with each other. Sometimes the line of volcanoes surrounding the Pacific is very narrow, as in Central America, and then again it broadens hundreds of miles, as in the western United States, where extinct volcanoes on the east edge of the belt are hundreds of miles from the ocean and distant from each other.

Within this great Pacific circle of volcanoes, twenty-five thousand miles in length, are many volcanic islands: the Ladrones, the Hawaiian Islands, with the famous Mauna Loa; the Galapagos, the Samoan Islands, as well as the Tonga and Fiji Archipelagoes, and many smaller groups. The coral islands may be also classed as volcanic, as they rest in great part on volcanic foundations.

Eastward from the circle around the Pacific, a branch belt extends through Sumatra and Java. On the broken isthmus which ages ago joined Asia and Australia are over one hundred volcanoes, many of which are constantly belching forth mud, lava, or ashes. This is the great focus of volcanic action of the earth.

Round nearly three sides of the Atlantic basin volcanic districts are scattered with some apparent symmetry. In the far north Hekla and nearly one score others separate the Atlantic from the Arctic Ocean. Stretching from Iceland, from north to south an irregular submerged ridge bears the volcanic mountains of the Azores, the Cape Verde Islands, Ascension, St. Helena, and Tristan da Cunha. On the west edge of the Atlantic are the volcanoes of the West Indies; but north or south of the Antilles there is not a single volcano on the east coast of America. The volcanic belt of the Mediterranean shore is prolonged to the mountains of Armenia and western Arabia. There are said to be some volcanoes in Thibet and Manchuria, but the explorer has not yet located them.

Elisée Reclus has drawn attention to the fact that the great centers of volcanic action in the western and eastern hemispheres are at exactly opposite ends of the globe—are at antipodes to each other—and that these centers of activity are near the poles of flattening. They also flank, one on the west and one on the east, the immense circle around the Pacific.

Volcanoes may be roughly described as of two types —the expulsive and the explosive. Of the first, Hekla, in Iceland, Stromboli, and Mauna Loa in the Hawaiian Islands, are good examples. They pour forth masses of lava which flows like molasses. Of the second type are Vesuvius, Mont Pelée, the volcanoes of the West Indies, and those of the Andes and Mexico; these eject the material andesite, and are more explosive than those ejecting the ropy lavas.

* National Geographic Magazine.

CAUSES OF VOLCANIC ACTION.

Theories abound as to the cause of volcanic action, but of actual causes we know little. Science has no X-rays to pierce into the bowels of the earth.

Lafcadio Hearn, in one of his interesting sketches of the French West Indies, published some years ago, tells the story of perhaps the only man who ever descended into the earth while it quaked. It seems that during a certain convulsion that shook and rent a certain island of the West Indies one man was thrown far down a fissure. He was unharmed, but his position, as he tumbled far down in the fissure, was not such as to inspire hope or a scientific study of what had happened or was happening. After some time passed there in the bowels of the earth, another convulsion shook and rent the ground. It tossed him up and up and out of the fissure and landed him unharmed on solid and firm ground; but when asked how it had all happened, the process of all this tossing, he could not explain. Science had lost its one chance of learning by personal observation what is happening beneath us.

Perhaps the most probable explanation of explosive eruptions of volcanoes is as follows:

The rocks deep beneath the surface are kept moist by the water that slowly seeps through. Probably the rocks contain from 3 to 20 per cent of water. The heat of the molten mass beneath the rocks gradually generates steam, and as time goes on more and more steam is generated. The pressure of this steam is constantly increasing until a time comes when the weight above cannot hold in the expanding force of the steam. Like a boiler, the whole mass explodes with terrific fury. An earthquake may open a fissure which, by letting down water rapidly, will hasten the explosion; but it is doubtful if an earthquake can do more than this. Water entering by a fissure could hardly invade the vast area upheaved by an explosive eruption.

The Guatemalan earthquake of April probably timed the explosion of Mont Pelée and La Soufrière. It was the last straw; it brought the last ounce of pressure—one ounce more than the boiler could bear. The local earthquakes in Martinique and St. Vincent were the ruptures and tremors caused by the fettered steam.

Two other factors may assist this process: The shrinking of the earth, which allows the molten mass to rise through fissures and generate steam more rapidly, and the change of load at the surface, caused by deposition or degradation, which thus disturbs the law of equilibrium.

Of eruptions in general Prof. Russell says:

"The cause of the rise of the molten rock in a volcano is still a matter of discussion. Certain geologists contend that steam is the sole motive power, while others consider that the lava is forced to the surface owing to pressure on the reservoir from which it comes. The view perhaps most favorably entertained at present in reference to the general nature of volcanic eruptions is that the rigid outer portion of the earth becomes fractured, owing principally to movements resulting from the shrinking of the cooling inner mass, and that the intensely hot material reached by the fissures, previously solid owing to pressure, becomes liquid when pressure is relieved, and is forced to the surface. As the molten material rises, it invades the water-charged rocks near the surface and acquires steam or the gases resulting from the decomposition of water, and a new force is added, which produces the most conspicuous and at times the most terrible phenomena accompanying eruptions.

"The recent volcanic outbreaks on Martinique and St. Vincent were eruptions of the explosive type. The volcanoes have been dormant for years, and the lava in the summit portion of their conduits was cold and hard. Movements in the earth's crust caused a fresh ascent of lava from deep below the surface, the molten material came in contact with water in the rocks it invaded, and steam explosions resulted.

"These explosions were similar to what would happen if water should be poured on a mass of molten slag such as comes from an iron furnace."

SOME ERUPTIONS OF THE PAST.

Prof. William M. Davis and Mr. William H. Snyder, in their excellent "Physical Geography" (Ginn & Co.), give a number of interesting instances of volcanic eruptions. I quote the following:

"Monte Nuovo (New Mountain) is a small volcano that was formed on the north side of the Gulf of Naples, in Italy, in 1538. Earthquakes occurred thereabouts for two years before the eruption, when in a week's time a cone was built up 440 feet high, half a mile in diameter at the base, and with a crater over 400 feet deep. Masses of lava 'as large as an ox' were shot into the air by the bursting of great bubbles of gas or steam that ascended through the lava in the vent. Finer ashes fell over the country for several miles around. The people of the neighboring villages fled in terror from their homes.

"A great eruption took place in Mexico in 1750, when the volcano Jorullo (pronounced Ho-rul-yo) was built on the central plateau, burying fertile fields of sugar cane and indigo. The outburst was preceded by earthquakes; the eruption continued half a year, building six cones and pouring out extensive lava flows. The highest cone, Jorullo, rose 700 feet above the plateau. The flows retained a perceptible heat for over 20 years.

"Many examples might be given of marine eruptions. In 1867 a shoal was discovered among the Tonga Islands of the Pacific (latitude 20 deg. 20 min. south, longitude 175 deg. 20 min. west), the surrounding sea floor being 1,000 fathoms deep. In 1877 smoke was seen ascending from the sea surface over the shoals. In October, 1885, an island had been formed two miles long and 200 feet high. At this time a terrific eruption was in progress, enormous clouds of constantly changing form rising over the island. The shocks of the explosion were felt on neighboring

islands, and the sound was heard 200 miles away. As the island consisted chiefly of ashes, it has since then been rapidly consumed by the waves, and will soon disappear unless new eruptions occur.

"In northern California there is a cinder cone of remarkably perfect form and certainly of recent date, although there is no record of its eruption. The cone, built of loose ashes, is 2,000 feet in diameter at its base, and rises 640 feet to a circular rim inclosing a crater 240 feet deep. It is perfectly barren. Although of moderate height, its ascent is difficult, as the ashes slide under a man's weight. A stream of lava emerges near the base of the cone, and, flowing westward into a neighboring valley, forms a large field a mile wide and nearly three miles long. The surface of the field is so covered with great clinkery blocks of lava as to be almost impassable. It is still unweathered and barren. The edge of the field is a steep clinkery slope 100 feet high. It obstructs a stream from the south, which forms Snag Lake, so called from the dead trees still standing in it. The lake outlet runs north along the west edge of the lava. On all sides the surface of the country is covered with a layer of volcanic ashes and dust, six or more feet deep near the cone, thinner and finer farther away, yet recognizable at a distance of eight miles. From the size of trees growing on the ashes, it is estimated that the cinder cone was built about 200 years ago. The lava flow is younger, but none of the Indians or early settlers thereabouts (1845) observed its eruption." G. H. G.

ADAM'S PEAK IN CEYLON.

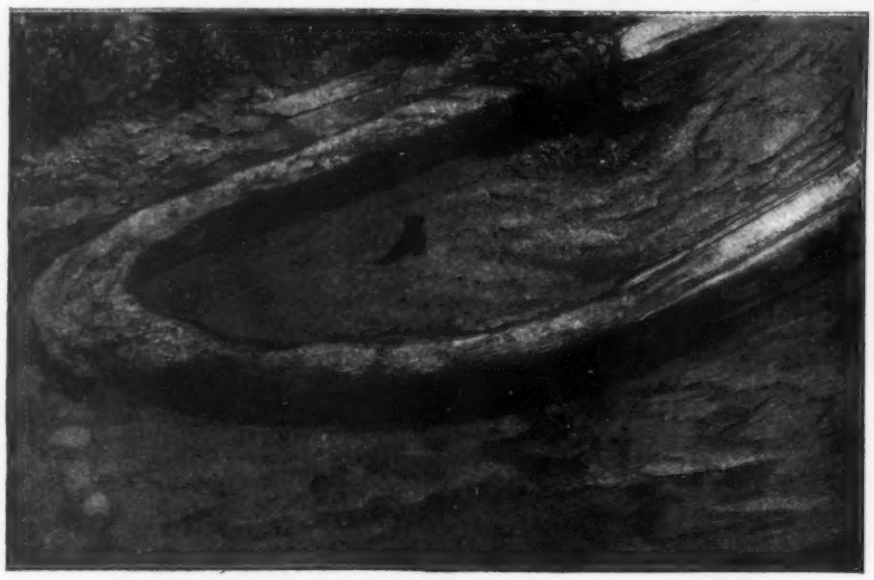
THE followers of Buddha in India, Burma, Siam and Ceylon venerate Adam's Peak as their sacred mount; for, on the summit, which rises abruptly like a needle of rock from the mountains of middle Ceylon, there is to be seen, according to their belief, the imprint of a foot of the Buddha. Singularly, the Mohammedans consider this natural depression as a footmark of our common ancestor, Adam. So that Mohammedans as well as Buddhists come every year in crowds from the most distant parts of the country to testify their reverence for this holy relic; like the Japanese in their regard for their sacred mount Fujiyama, and the Chinese in a similar esteem for their Taishan in the heart of Shantung.

As, in the course of years, I have ascended these two mountains and published descriptions and photographic views, I undertook at the beginning of this year the same task with respect to Adam's Peak, less on account of the sacred footprint than because of the remarkable natural spectacle, which has made this mount famous to Europeans; at sunrise Adam's Peak throws a sharply defined shadow, as deep as it is regular. This fact has been mentioned by various travelers, and it is even reported that the shadow has been seen from ships at sea, approaching the harbor of Colombo. But this is denied by the captains of the vessels plying regularly between Ceylon and the harbors of southern India. To some who have been sailing in these waters for many years, the precipitous top of the mount, which appears as sharp as a needle, affords a sign for steering their ships, but they have never observed the celebrated shadow from shipboard. I searched in vain in stores where Indian and Ceylon photographs are kept for views of the summit with the footprint and the temples built there, and decided to take the views myself.

Whoever gazes from below at the lofty peak, rising abruptly like an Indian Matterhorn from the towering masses of Ceylon, considers the ascent much more difficult than it really is. Not only do numerous pilgrims climb to the summit, but Europeans make the ascent every year; some of these, however, would hardly care to repeat it.

By dauntless enterprise a railway has been built in the mountains of Ceylon, and from Hatton, one of its stations, a convenient footpath leads, a distance of about 20 kilometers, to the inn on the Maskeliya, which is situated in a valley at the foot of Adam's Peak. From here I started at midnight, accompanied by two guides and lantern bearers, and reached the peak three hours later by gradual ascent. The climbing of the bare steep granite rock, which has a height of 2,260 meters, is less dangerous than fatiguing. In the upper part, in order to overcome the worst obstacles, series of steps have been cut in the naked rock, and iron chains are strung along similar to those on the Matterhorn.

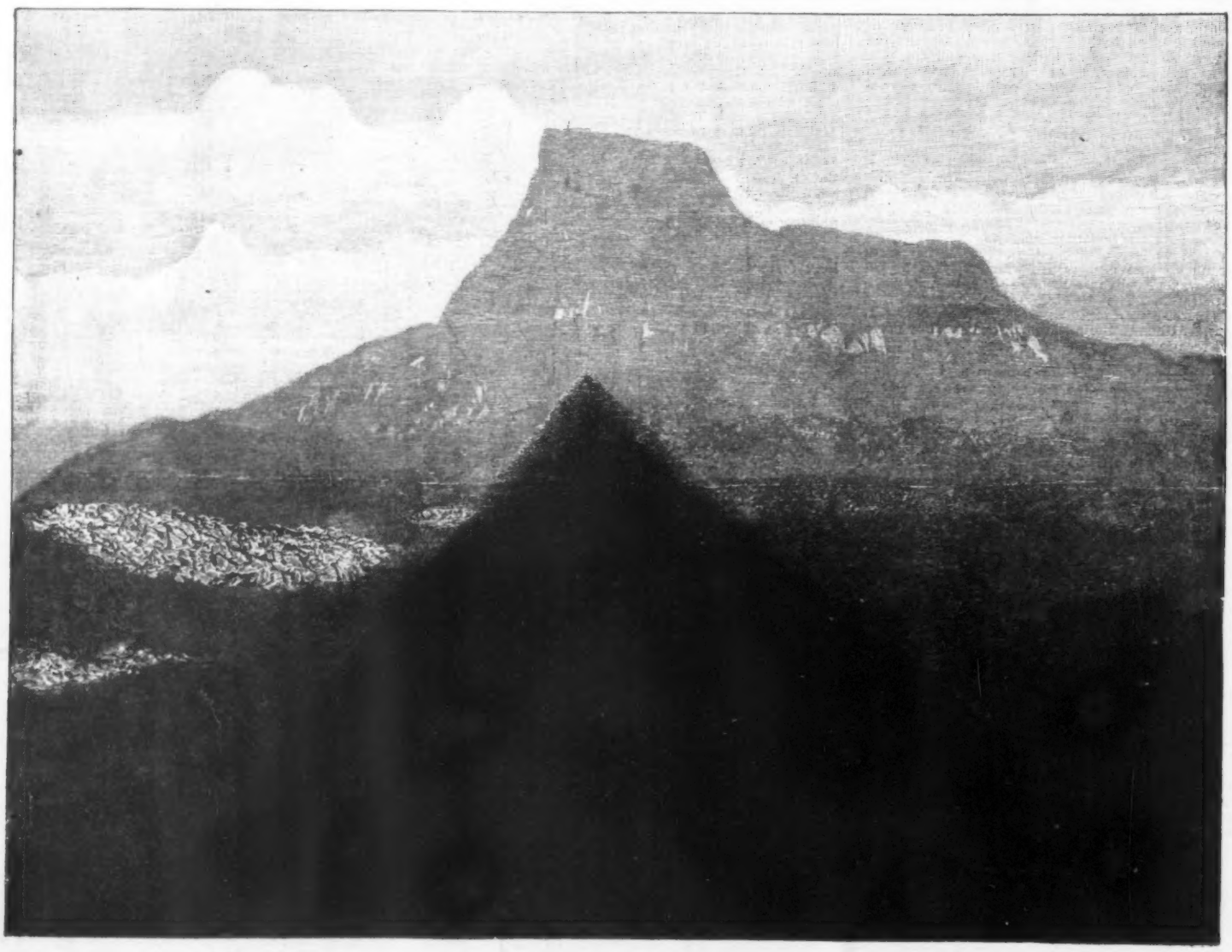
At 6 o'clock in the morning we reached the summit.



ADAM'S FOOTPRINT ON ADAM'S PEAK.

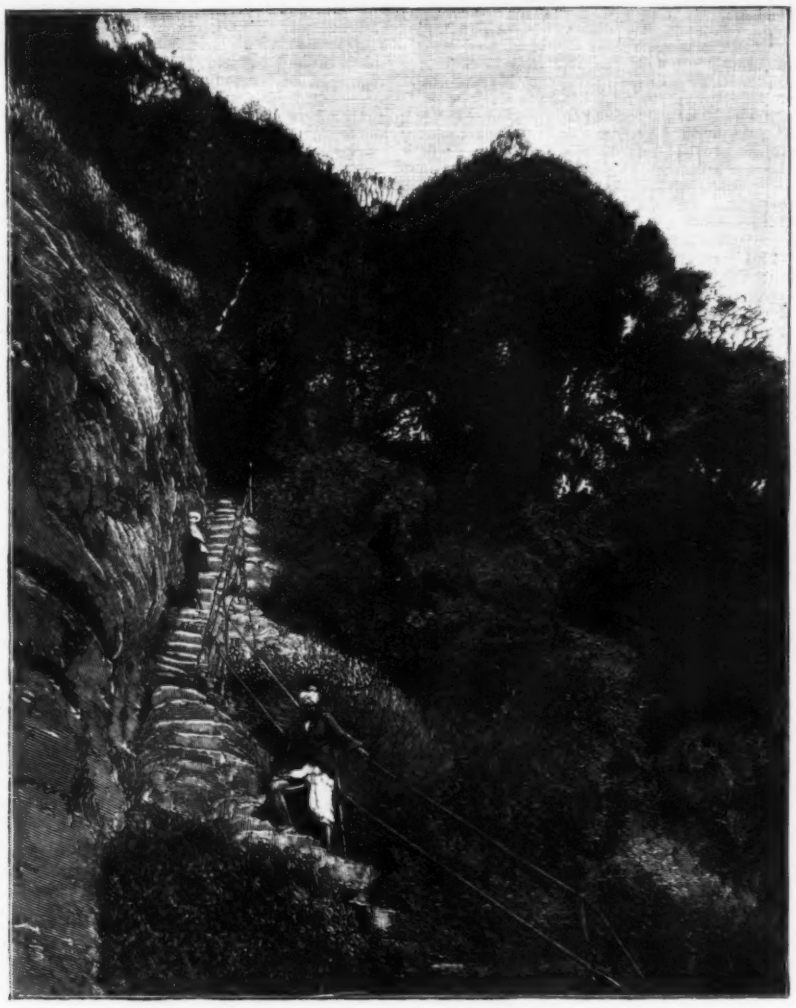
For comparison of the size a lady's shoe is sketched on.

The plateau, which may have a circumference of one hundred steps, is inclosed by a wall breast high. Inside are a few low huts for the priests of Buddha and the pilgrims. From the center of the plateau rises the granite rock 20 meters higher still, and on its very apex stands a small temple, open on all sides, in which the celebrated footprint is to be seen. This is here represented for the first time. (See illustration.) It requires a great deal of imagination to view this depression in the rock as the print of a human foot. The



SHADOW OF ADAM'S PEAK AT SUNRISE. THE BIBLE MOUNTAIN IN THE BACKGROUND.

Adam's Peak in Ceylon. From photograph by E. von Hesse-Wartegg.



SECTION OF THE ASCENT TO ADAM'S PEAK.

individual must have been of gigantic stature, for the length of the footprint, according to my measurement, amounts to 1.40 meters, and the width 65 centimeters. On the south side stands a small altar, on which the priests and pilgrims at sunrise deposit delicate white frangipani blossoms and grains of rice; afterward kneeling with clasped hands and offering their prayers.

At 18 minutes past 6 o'clock a priest called my attention to the splendid disk of the sun, which appeared in the east in a saddle of the highest mountain of Ceylon, the Pedrotallagalla. Opposite, on the west side, was seen the peculiar sharply defined shadow of Adam's Peak in magnificent grandeur. Like a dark pyramid of mist, it stood out from the gray background, which gradually became brighter. The higher the sun rose the lower the shadow sank, until finally it lay deep on the mountains at our feet. In two hours and a half after sunrise it faded away. This phenomenon is so peculiar and majestic that it keeps one from paying full attention to the splendid view presented from this lofty peak in every direction over this tropical island, so extraordinarily blessed. It was strange that half an hour after sunrise there appeared by the side of the principal shadow of the mount two others, paler, starting from the top and lower down diverging in direction; these shadows disappeared gradually.

The descent under the scorching rays of the tropical sun proved very troublesome; here and there we passed over smooth granite walls, steep places of 65 deg. Yet the rare spectacle of natural beauty was so grand and unique that I can well recommend the ascent of Adam's Peak to every tourist. There is more occasion to visit this peak than the sacred mountain of the Japanese, the Fujiyama.—For our illustrations and the accompanying description we are indebted to Illustrirte Zeitung.

THE CRETAN EXCAVATIONS.

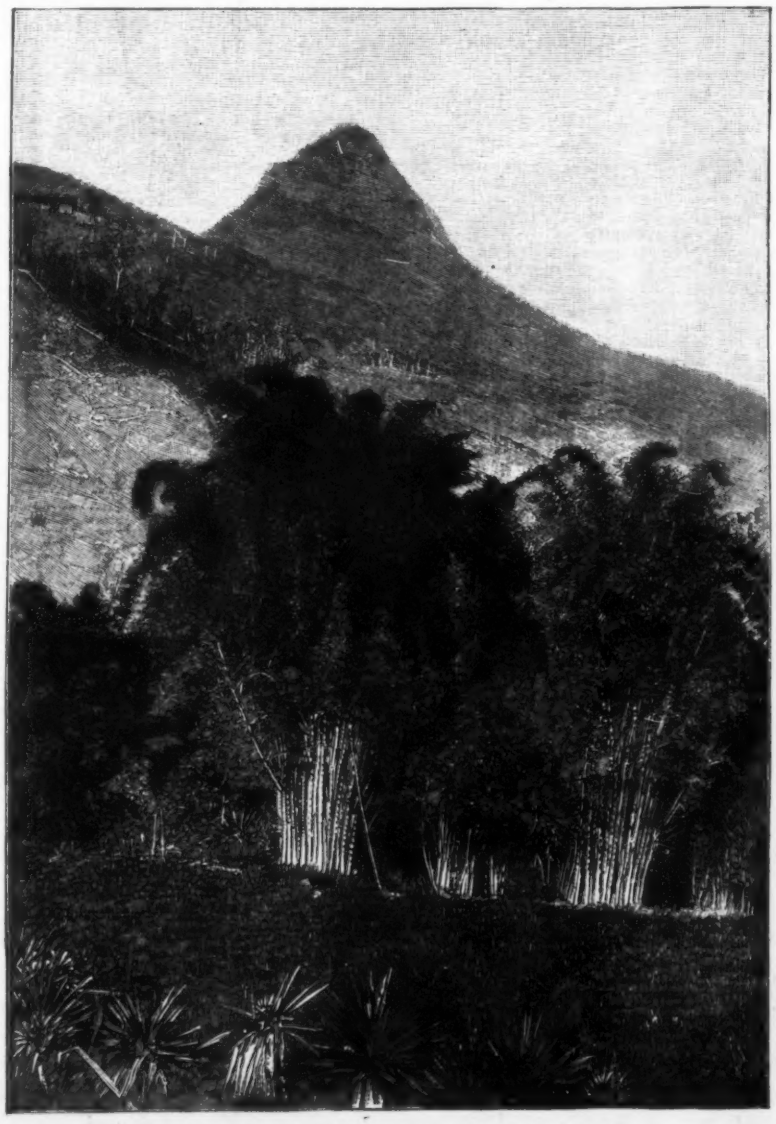
"On February 14 last," says Arthur J. Evans in The London Times, writing from Candia, "I was able, thanks to the generous assistance given through the Cretan Excavation Fund, to resume the work of excavation in the prehistoric Palace of Knossos.

"Those who have followed the former course of the excavations may remember that their result had been to uncover an eastern wing, which seems to have been mainly reserved for state and religious functions, business and storage, a great central court, and beyond it to the east a part of what seemed to be the royal residential quarter. At the close of last season's work a staircase had come to light here leading down by a triple flight to a hall with double tiers of colonnades, and beyond it a larger columnar hall or Megaron. On the upper level north of these ran a corridor, beneath which another corresponding passage of lofty dimensions has now been cleared out, originally lit by a large window opening on the light well of the larger hall. The clearance of this was marked by the discovery of a very extensive deposit of inscribed clay tablets—the largest, indeed, yet discovered—including about one hundred perfect documents dealing with palace accounts. The decimal system is here much in evidence, and a large proportion of the tablets deal with percentages. With these were several large clay impressions of what must certainly have been a royal signet ring, exhibiting a goddess and her attendants, of which a counterfeit matrix was found last year in another part of the building—a proof that fraudulent procedure was not unknown even in the household of Minos.

"A very interesting feature of the newly discovered hall, which will be specially appreciated by Homeric students, is a private staircase opening to its north wall and leading up by a double flight to upper rooms. On the west side of the hall opens a passage leading to what must have been the most secluded part of this residential quarter of the palace. Here again remains of the upper floor levels are well preserved, and a stone bench is still in its place against the wall of one of the upper rooms. The innermost of this group of chambers have as yet been incompletely excavated, but the work here has already been productive of some important results. At one point are remains of what appears to have been a wooden staircase, the upper part of which was found literally choked with broken seal impressions, from what must certainly have been a secretary's office on the upper floor. One of these impressions, though only a fragment, is of great interest as bearing part of the impress of a late Babylonian cylinder, thus supplying direct proof of correspondence with the East. A very remarkable feature of this quarter of the palace is the elaborate drainage system. The well paved floors are underlaid by quite a network of stone channels, in places crossing each other at different levels, and roomy enough to allow a man to crawl along them. A succession of stone shafts leads down to these from the upper story, in one case apparently connected with a latrine, of which a curious and in some respects very modern example also occurs on the ground floor. In another part of the palace sections of a terra cotta drain pipe have been found of a most advanced form, provided with stop ridges.

"On the eastern slope of the hill the limits of the palace have extended themselves beyond all anticipation. A good deal of denudation has here taken place, but among the finds are remains of a large architectural fresco with realistic imitation of veined marble, and stone jars more capacious than any yet brought to light. A stone spout jutting out from a neighboring wall and connected by a conduit with an oil press above explained at once their contents and means of filling. Further down, and here forming the outer eastern boundary of the palace, are massive lines of supporting walls; at one place five are within another at intervals of only a foot or so, and a bastion with ascending flights of steps flanked by curious water runnels.

"The remains already brought to light cover an area of about five acres, and their exploration may be said to have opened to the eyes of history a new world, already ancient when Homer sang, but presenting a civilization in some respects strangely modern. It would seem, indeed, as if the brilliant and unexpected character of the finds was likely to maintain itself to the last. The exploration, now proceeding, of the basement spaces within the upper Eastern Terrace has brought to light, below the level of the later palace, walls belonging to a still earlier royal dwelling. With-



ADAM'S PEAK, SEEN FROM THE INN OF LAXAPANA.

in these were fine painted vases of the older class, the decorative designs and elegant contour of which sufficiently attest the high artistic development attained here in this still more archaic period. In this early stratum was also found a miniature vase of gold and porcelain, the thimblelike receptacle of which may have contained some perfume as precious as attar of roses.

"Here, too, as if to illustrate the continuity of the local cult, were remains of a miniature pillar shrine of painted terra cotta with doves perched on its roof. But one of the later palace basements, at a slightly higher level than this, contained an architectural record of still more universal interest. This is the remains of a mosaic, consisting of certain small porcelain plaques, which in its original form seems to have represented scenes disposed in various zones recalling the subjects of Achilles' shield—the walls and houses of a city, a river, a vine and other trees, warriors with bows, spears and throwing sticks, besiegers and defenders, and various animals. But the most surprising part of all are the houses of which the city is composed. Fragmentary as are their remains, it has been possible to reconstitute about a couple of score of these. The varying character of the structure—stone, timber and plastered rubble—is accurately reproduced, and the walls, towers and gateways, a whole street of a Minoan city rises before us much as it originally stood. But what is even more surprising than the fact that the elevations of these prehistoric structures should be thus recovered for us intact from the gulf of time is the altogether modern character of some of their features. Here are three-storied houses (some of the semi-detached class showing two contiguous doorways), with windows of four panes, or double windows of three panes each, which seem to show that the inmates of the houses had actually some substitute for glass."

THE GERMAN ARCHÆOLOGICAL EXPEDITION AT BABYLON—SOME REMARKABLE DISCOVERIES.

THE German expedition that was organized for excavating and exploring the ancient city of Babylon and other ruined and buried cities in Mesopotamia has succeeded in making some valuable discoveries of great archæological interest. The expedition is under the superintendence of Dr. Koldwey, supported by several well-known German archæologists, including Dr. Weissbach and Mr. André.

The expedition has installed its headquarters at Babylon, so that the investigations may be carried out expeditiously and with facility, the members of the party drawing their food supplies and other requirements from Bagdad, which is only 60 miles distant, as the exigencies demand.

The country surrounding Babylon is for the most part a dreary sand-swept desert, almost utterly devoid of vegetation. Beneath the wastes of sand, however, are buried monuments of inestimable value and interest to the assyriologist, and the excavations of the German expedition will supply much interesting information regarding the Assyrians, both anterior and after the fall of the country into the hands of the Persians. One of the most imposing features of the country, forming a prominent landmark, are the ruins of the tower of Babel, measuring approximately 100 feet square and towering into the air for a height of 150 feet.

That Mesopotamia was once a fertile, flourishing country is testified by the numerous courses of canals that have been unearthed, for irrigating the country and providing intercommunication with the Euphrates, which was the great water highway in the time Babylon was at the zenith of its glory and prosperity.

One of the greatest works upon which the German expedition is busily employed is the transcription from the Assyrian of the innumerable cuneiform inscriptions upon the bricks, pottery and tiles excavated from Nebuchadnezzar's palace. Curiously enough, next September celebrates the centenary of cuneiform knowledge, for it was just a hundred years ago that the first of these characters were comprehended and translated.

Dr. Koldwey has been engaged for some three years upon this task. The work of excavating is carried out by Arab laborers, of whom there are about 200 at work; and the bricks and pottery as they are unearthed are conveyed in baskets, upon a miniature railway that has been specially built for the purpose, to the building occupied by the leader of the expedition, and his assistants, and the hieroglyphics are there carefully deciphered and recorded. To a great extent the Arabs and various tribes of the desert, however, have made severe depredations upon the ruins to obtain the bricks for the erection of their own domiciles, etc., since it is impossible to manufacture bricks equal to the standard of those employed by the ancient Assyrians for their buildings.

When the French Assyrian expedition surveyed Babylon fifty years ago, they pronounced the city, as the result of their investigations, to be approximately fifteen miles square. But these dimensions have been proved by Dr. Koldwey's researches to be entirely fallacious. Indeed, Babylon appears to have been a very small, compact city.

The results of the excavations have proved one very strange characteristic of the ancient Assyrians in connection with the erection of their domiciles. The country of Mesopotamia is, on the whole, rather flat and uninteresting, and the configurations of the ground being so slight, did not permit of the houses being built upon overlooking eminences. These deficiencies in natural points of vantage, therefore, had to be compensated by building extensive and high substructures, or foundations, in order to raise the buildings to the requisite height. Great competition was evidently made between the various wealthy inhabitants of Babylon, in order to enable one resident to look down upon the dwelling of another. At the present day, the same practice is adopted in Bagdad and other neighboring towns, where the residences of the wealthy are to be seen towering above the others.

So far Dr. Koldwey has succeeded in laying bare about three-quarters of the former magnificent palace of Nebuchadnezzar, the Assyrian king. The superstructure of the spacious pile has completely disappeared, but the foundations are for the most part still existent. The Temple of Melita is also in a fair state of preservation, so that a tolerably correct idea of the dimensions of its apartments may be obtained.

The "Kasr," which has been unearthed, measures about 1500 feet in length by 900 feet in width, and incloses a temple, three palaces and a canal. The buildings were constructed almost entirely of mud sun-baked bricks, remarkably well manufactured and durable, not being affected by any atmospheric agencies, and whitewashed walls. One very noticeable feature of the apartments of the palace is their small dimensions. The largest of them—the great hall in which the mysterious writing on the wall, *Mene Mene Tekel Upharsin*, appeared to Belshazzar during his feast—only measures 60 feet in length by 50 feet in width. This appears to have been the most important room in the southern palace, which from an architectural point of view, was apparently the most beautiful residence. This hall has a frontage to the south, and commands an aspect over the greater part of the city. At the entrance to the hall is a small court with a well, and it appears to have been sheltered by a portico. Outside is the outer wall of the palace, which drops precipitously into what was formerly a canal or ramification of the river Euphrates, the course of which, it will be recollected, was diverted by the Persian invaders of Babylon, to permit the passage of the soldiers into the city. At the left of the entrance to the hall extends a bitumen-covered pavement, which has been discovered almost intact, leading to the point where a bridge evidently spanned the river surrounding the city.

The general plan of the city of Babylon appears, from the investigations, to have been triangular, and Dr. Koldwey estimates that the total length of the walls inclosing two sides of the area was approximately eight miles, so that Babylon was comparatively only a small city. Neither do the excavations testify to the fact that ancient Babylon was at all a magnificent city, either in architectural adornment or decorative embellishment. In fact, it appears to have been purely conventional, and is far eclipsed to-day by some of the magnificent old cities of India and China, though without a doubt it was the most imposing city in Mesopotamia.

One of the most important objects of the German expedition is to obtain some reliable data regarding the system and schemes for irrigation adopted by the Babylonians. The country, as the records already discovered prove, was never a very fertile one, and was almost devoid of vegetation. Nebuchadnezzar, as the cuneiform characters show, used various woods in the construction of his temples, but they were apparently obtained from outside Assyria. At any rate, Nebuchadnezzar was deeply interested in the work of irrigating the country by means of canals, and the discovered records show that the Babylonian king had drawn up an elaborate system of artificial waterways. The country is freely intersected with canals of various sizes, but they fell into desuetude centuries and centuries ago, and their very existence is almost entirely obliterated, so that the obtaining of reliable information upon this subject has been rendered extremely difficult. And the researches have been made increasingly arduous by the fact that many of the canals unearthed have since proved to date from the era when Mahomet lived in the land.

The expedition is carrying out its exploration with commendable thoroughness. Every part of the city is being excavated, and the resultant discoveries duly recorded. When Babylon itself is completed, the explorers will set to work upon the numerous outlying towns. The work of excavation by native Arab labor costs about 12 cents a day per man, and is considered to be a high wage, so that abundant labor is accessible. Then, if any important discovery is made, the finder receives further reward, so that the zeal of the men is stimulated, and the risk of robbery is diminished. By these efforts the Babylon of thousands of years ago is being laid bare; and for the first time reliable information regarding the life, arts and crafts and characteristics of the ancient extinct Assyrians is being compiled, so that the historical and archæological value of the work can be adequately comprehended.

THE LAWS OF NATURE.*

By S. P. LANGLEY.

WE say that nature is unchanging, and so perhaps it is, in the eye of some eternal beings, but not in ours, for the things that we see from day to day, appear permanent only by comparison with the duration of our own brief life, and our own little experience.

An inhabitant of the land where nature has just passed through such an awful convulsion, with a loss of life greater for so short a time than history has ever recorded, might have said in the morning that nature never changes, because it had never changed in his own little experience; but he would not have said so at that day's close. Now the experience of the entire human race is far briefer relatively to nature's duration than that of one of these islanders who knew the green mountain with its fresh lakes only as a place of quiet rest, up to the moment when the gates of hell were opened under it.

Nature, then, really changes, and would apparently do so if man were not here; for it is not man's varying thoughts about nature that make her change. But there is something quite different which does change because of man, and which apparently would not change if he were not here. This is what he calls the "laws of nature." The assumption that there are such things is due to him, and such "laws" are known only through his mind, in which alone nature is seen.

It is perhaps a hard saying to most that there are no such things as "laws of nature"; but this is the theme on which I have to speak.

These, then, are the laws of man's own mind, or the effects of his own mind, which he projects outside of himself and imagines to be due to some permanent and unalterable cause having an independent existence. This is not only because his season for observation is but a moment in the passage of nature's eternal year, and because with his pathetic sense of his own weakness he would gladly stay himself on the word of some unchanging being. It is because this sense of dependence is strangely joined with such self-conceit that when he listens to what he himself says, he calls it the voice of God. From these twin causes, arising both from his inability as a creature of time to observe nature, which is eternal, and again from his own overweening sense of his own capacity to know her, he looks for some immutable being whom he believes to have written his own ideas in what he calls "the book of nature."

I am not questioning the existence of such a being as the "Author of Nature"; but asking if such a volume as is imputed to him, ever really existed. The very phrase, book of nature, is a legacy from moribund mediæval notions of a lawgiver; and it, with the vitality of words which carry to us dying ideas, has lived on to our own time, when we can no longer believe it in our hearts, although it is still upon our lips.

To convince ourselves, we need only pause a moment to ask the simple question whether there is any authority who has prepared such a clearly written book of statutes in which we can really read nature's laws.

The question answers itself.

I repeat that I am not denying here the existence of such a being as the imputed author of these laws, but say that, ignorant as we are of what is being done by him, we cannot read his thoughts in our momentary vision of what is forever passing.

"For my thoughts are not your thoughts, neither are your ways my ways, saith the Lord" is a caution which, whether believers or not, it would not harm us to consider; and when we say that these "thoughts" are written in "the book of nature," this cannot mean that they are legible there as in a statute book where he who runs may read. If nature is to be compared to a book at all, it is to a book in the hands of an infant to whom it conveys little meaning, for such are we; or rather it is like a "book of celestial hieroglyphs, of which even prophets are happy that they can read here a line and there a line."

I hope what I am trying to say may not bear the appearance of some metaphysical refinement on common sense. It is common sense that is intended, and the "laws of nature" that seem to me a metaphysical phrase.

To decorate our own guesses at nature's meaning with the name "laws of nature" is a presumption due to our own feeble human nature, which we can forgive for demanding something more permanent than itself, but which also leads us to have such an exalted conceit of our own opinions as to hide from ourselves that it is these very opinions which we call nature's laws.

The history of the past shows that once most philosophers, even atheists, thus regarded the "Laws of Nature," not as their own interpretations of her, but as something external to themselves, as entities partaking the attributes of Deity—entities which they deified in print with capital letters—as we sometimes do still though these "Laws" now are shorn of "the glories of their birth and state" which they once wore, and are not turning out to be "substantial things."

But are there not really things (like the fact of gravitation, for instance) external to ourselves, which would exist whether we were here or not, and which are part of the order of nature? Apparently, yes, but part of the *laws* of nature no!

The phrase even yet exercises a wide influence, though it has seemed to me that a significant change is taking place in the leaders of common opinion with regard to the meaning that the words convey.

I presume that the greater proportion of us here are interested in science. I may indeed assume that we all are; and I want to inquire what lesson for us, as students of nature, there lies in the fact that we are no longer impressed by her "laws" as were the scientific men of a former generation.

It is convenient to measure the distance we have passed over, by the fact that one hundred and fifty years ago, one of the acutest of reasoners, David Hume, published a still celebrated argument against miracles, which within my own recollection was held to be so formidable that those who were reluctant to believe in his conclusions, were still unable to offer a good refutation. The immense number of attempted refutations and their contradictory character are perhaps the best testimony for this.

Hume defines a miracle as a violation of the "laws of nature," and his argument, concisely stated, is that there must "be a uniform experience against every miraculous event, otherwise the event would not merit that appellation, and as a uniform experience amounts to a proof, there is here a direct and full proof from the nature of the fact against the existence of any miracle."

Now while his argument is logically as conclusive as ever, it to-day convinces only those who are anxious to accept its conclusion.

What is the reason for this great change?

We may ask what the laws of nature really are, and pass from what they were thought to be by Hume to what they are beginning to be understood to be by us, without here inquiring into the intermediate steps which brought the change about.

It seems to me that the argument which was conclusive not merely to the learned, but to the common cultivated thought of Hume's time has never been expressly refuted when its premises were admitted (and the generation following him admitted them); and yet this compelling argument, as it once seemed, is gradually losing its force to most minds, not through counter argument, but by an insensible change of opinion in the attitude of the thinking part of our public as compared with his, a change about certain fundamental assumptions on which the argument rested, and from his own views of the universe to those we are beginning to take.

In the first place, the immensely greater number of things we know in almost every department of science beyond those which were known one hun-

* A paper read before the Philosophical Society of Washington, May 10, 1902.

fired and fifty years ago, has had an effect which doubtless could have been anticipated, but yet which we may not have wholly expected. It is, that the more we know, the more we recognize our ignorance, and the more we have a sense of the mystery of the universe and the limitations of our knowledge.

I believe it may be said that, if not to Hume, at any rate to the majority of those about him, and to his later contemporaries, there was very much less mystery in the world than we see in it, and if it were then still occasionally said that there were "things in heaven and earth not dreamt of in 'their' philosophy," these words must have struck on the self-complacent minds of his generation as something to be tolerated as poetic license, rather than as accurate in philosophic meaning. Compared with ours, that whole century was satisfied with itself and its knowledge of the infinite, and content in its happy belief that it knew nearly everything that was really worth knowing. This "nearly everything" which it thought it knew about the universe, it called the "laws of nature."

It was to this belief in the general mind, I think, that the success of Hume's argument was due.

The present generation has begun, if not to be modest or humble, to be somewhat less arrogant in the assumption of its knowledge. We are perhaps beginning to understand, not in a purely poetical sense, but in a very real one, that there may be all around us in heaven and earth, things beyond measure, of which "philosophy" not only knows nothing, but has not dreamed.

As a consequence of this, there is growing to be an unspoken, rather than clearly formulated, admission that we know little of the order of nature, and nothing at all of the "laws" of nature.

Now if we are at present at least, disposed to speak of an observed "order" of nature (not carrying with it the implication of necessity denoted by "law"), I think we have some reason to say that there is a prescience of a change in common thought about this matter, and that it is owing to this that we are coming to be where we are.

I do not know that there is a less wide belief in the gospel miracles in our day, but if it were so, the decline in the weight given Hume's argument is not due solely to that, for it may surely be said that it was not merely an argument against gospel miracles, but against all the prodigies to be found in history, sacred and profane, where he doubtless had in mind traditions of stones falling out of heaven, cures wrought by psychological agency, and the like, all "superstitions" to the men of his day. These if they no longer believed in a deity, were none the less shocked by the culpable existence of such vulgar beliefs in conflict with the deified "laws of nature," while such "superstitions" have in our day become subjects of modest inquiry.

Let me quote from a later writer, whose point of view is singularly different from that of Hume and his contemporaries, and who in answer to the question, "What is a miracle?" begins by reminding us that the reply will depend very much upon the intelligence of the being who answers it, or whom the miracle is wrought for.

" To my *horse*, do I not work a miracle every time I open for him an impassable turnpike?"

"But is not a real miracle simply a violation of the 'laws of nature'? ask several. What are the laws of nature? 'Is it not the deepest law of nature that she be constant?' cries the illuminated class; 'is not the machine of the universe fixed to move by unalterable rules?'

"I believe that nature, that the universe, which no one whom it so pleases can be prevented from calling a machine, does move by the most unalterable rules. And now I make the old inquiry as to what those same unalterable rules, forming the complete statute-book of nature, may possibly be?

" 'They stand written in our works of science,' say you, 'in the accumulated records of man's experience.' Was man with his experience present at the creation then, to see how it all went on? Have any deepest scientific individuals yet dived down to the foundations of the universe, and gaged everything there? Alas, these scientific individuals have been nowhere but where we also are; have seen some handbreadths deeper than we see into the deep that is infinite, without bottom as without shore.

"Philosophy complains that custom has hoodwinked us from the first; that we do everything by custom, even believe by it; that our very axioms, boast as we may, are oftenest simply such beliefs as we have never heard questioned. Innumerable are the illusions of custom, but of all these perhaps the cleverest is her knack of persuading us that the miraculous, by simple repetition, ceases to be miraculous!"

A lesson for us, as people who are most of us interested in science, showing how little its most fixed conclusions may be worth, may perhaps be conveyed in an example. A century and a half ago, when the new science of chemistry won its first triumphs, the fundamental discovery which was to illuminate the whole science, the settled acquisition which it seemed to have brought to us, the thing which was going to last, was "phlogiston."

This had everything to recommend it, in universal acceptance, and in what seemed to the foremost men of the time, its absolute certainty.

"If any opinion," says Priestley, "in all the modern doctrine concerning air be well founded, it is certainly this, that nitrous air is highly charged with phlogiston. If I have completely ascertained anything at all relating to air it is this."

I am trying here to say that laws of nature are little else than man's hypotheses about nature.

Phlogiston was then to the science of a former age, in this sense a law of nature, at least as great a generalization as the kinetic theory of gases is to us; as widely accepted, as firmly believed and as certainly known—but what has become of it now?

Can we tell, then, in advance by any criterion what a "law of nature" is?

With a curious begging of the question some answer, "Yes, for laws of nature have this distinction, that they have never been disproved." As if one were to say, Yes, because when they *are* disproved we deny that they are laws of nature!

Those of us who are capable of being instructed or warned by the history of human thought may, then, ask what kind of a guarantee are we to have for any other "fact" of our new knowledge? May they not—all these "facts"—be gone like the baseless fabric of this vision, before another hundred years are passed?

The physical sciences seem to have had less change in their theories than the mighty displacements in other branches of natural knowledge, but it is a truism to say that all are changed, and it should be a truism to add that the "laws of nature" are not to us what they were a hundred years ago.

I repeat that of the "order" of nature we may possibly know a little; but what are these "laws" of nature? What celestial act of congress fixed them? In what statute book do we read them? What guarantees them? Our mistake is in believing that there is any such thing, apart from our own fallible judgment, for the thing which the "laws of nature" most absolutely forbid one generation to believe, if it only actually happens, is accepted as a part of them by the succeeding.

Suppose that a century ago, in the year 1802, certain French Academicians, believing like everyone else then in the "laws of nature," were invited, in the light of the best scientific knowledge of the day, to name the most grotesque and outrageous violation of them which the human mind could conceive. I may suppose them to reply, "if a cartload of black stones were to tumble out of the blue sky above us, before our eyes, in this very France, we should call *that* a violation of the laws of nature, indeed!" Yet the next year, not one, but many, cartloads of black stones did tumble out of the blue sky, not in some far-off land, but in France itself.

It is of interest to ask what became of the "laws of nature" after such a terrible blow. The "laws of nature" were adjusted, and after being enlarged by a little patching, so as to take in the new fact, were found to be just as good as ever! So it is always; when the miracle *has* happened, then and only then it becomes most clear that it was no miracle at all, and that no "law of nature" has been broken.

Applying the parable to ourselves then, how shall we deal with new "facts" which are on trial, things perhaps not wholly demonstrated, yet partly plausible? During the very last generation hypnotism was such a violation of natural law. Now it is a part of it. What shall we say, again, about telepathy, which seemed so absurd to most of us a dozen years ago? I do not say there is such a thing now, but I would like to take the occasion to express my feeling that Sir William Crookes, as president of the British Association, took the right, as he took the courageous, course in speaking of it in the terms he did. I might cite other things, the objects of ridicule only a few years ago, of debate now, but which have not all found supporters who possess the courage of their convictions.

The lesson for us in dealing with them is not that we should refuse to believe, on the one hand, and sneer at everything which is on its trial; for this, though a very general and safe procedure, is not the one to be recommended to those of us who have some higher ideal than acquiescence with the current belief.

The lesson for us is that we must not consider that anything is absolutely settled or true.

This is not to say that we are to be blown about by every wind of scientific doctrine. It is to be understood as a practical rule of life, that we must act with the majority where our faith does not compel us to do otherwise; but it seems to me that we must always keep ready for use somewhere, in the background of our mind possibly, but somewhere, the perhaps trite notion that we know nothing absolutely or in its essence; and remember that though trite it is always true, and to be kept as a guide at every turning of the scientific road, when we cannot tell what is coming next.

How many doctrines of our own day will stand the light of the next century? What will they be saying of our doctrine of evolution *then?* I do not know; but let me repeat what I have said elsewhere, that the truths of the scientific church are not dogmas, but something put forward as provisional only, and which her most faithful children are welcome to disprove if they can. I believe that science as a whole is advancing with hitherto unknown rapidity, but that the evidence of this advance is not in reasoning, but in the observation that our doctrine is proving itself, by the fact that through its aid nature obeys us more and more, as I certainly believe it does.

Never let us forget, however, that man being the servant and interpreter of nature, as Bacon says, can do and understand so much, and so much only, as he has *observed* of the course of nature, and that beyond this he neither knows anything nor can do anything. No walk along "the high priori road" will take him where he wants to go and no "law of nature" will certainly help him.

But these "laws," having authority only as far as they are settled by evidence, and by observation alone, it may be a just inquiry as to what constitutes observation, and above all, who judges the evidence. If the kinetic theory of gases, for instance, is a matter of inference rather than of observation, are we sure that we have a better guarantee for it than a previous century had for phlogiston? Our good opinion of ourselves, as compared with our scientific fathers, makes us think we have. I think myself that we have; and yet, remember, it is the same human nature which judged that evidence then, that judges this evidence now, and remember that however rapidly science changes, human nature remains very much the same, and always has a good conceit of itself.

While we are venturing to utter truisms, I repeat, let us take once more this one, home to ourselves, that there is a great deal of this "human nature" even in the best type of the scientific man, and that we of this twentieth century share it with our predecessors, on whom we look pityingly, as our successors will look on us.

Let us repeat, and repeat once more, that though nature be external to ourselves, the so-called "laws of nature" are from within—laws of our own minds—and a simple product of our human nature. Let us agree that the scientific imagination can suggest questions to put to nature, but not her answers. Let us read Bacon again, and agree with him that we understand only what we have observed. Finally let us add that we never understand even that, in the fullness of its meaning, for remember that of all the so-called laws of nature the most constantly observed and most intimately and personally known to us, are those of life and death—and how much do we know about the meaning of *them?*

SLEEP PRODUCERS.*

By J. H. KELLOGG, M.D.

THERE are many chronic invalids and others who cannot sleep. Usually the chief reason for this condition is, that they do not work. The Bible says, "He that will not work, shall not eat." And nature says, "He that does not work, shall not sleep." Work is just as necessary for sleep as it is for an appetite. A person must earn an appetite if he has one. So, if one is to enjoy sound, refreshing sleep, he must earn it. The Bible says that the sleep of the laboring man is sweet. The chronic invalid is sedentary; he has no vigor for exercise. Because he does not work or exercise, there are certain poisons which are not eliminated. These accumulate in his body, and irritate the nerve cells, thus keeping him awake.

A number of years ago Prof. Bouchard found by experimenting upon rabbits that there was a marked difference in the urinary secretions generated during sleep and those generated during activity in the open air. It was found that when a rabbit was injected with the urinary secretion of the day he would fall asleep, like an animal that had been put under the influence of opium. When the same amount of the secretions of the night were injected into the veins of the rabbit, it produced a spasm.

The exercise which a man takes in the open air, produces substances adapted to make him sleep. When a boy comes home from coasting, and sits down by the warm fire, it is not more than five minutes before he is nodding. And when he goes to sleep after such exercise, his sleep is refreshing and sweet, like that of an infant. This is because of the generation within the body of substances which have power to put an animal to sleep. This is the reason the sleep of the laboring man is sweet. It is the reason exercise is a means which enables us to sleep.

On the other hand, while a man is sleeping, by degrees a substance accumulates which produces convulsions, and after eight or nine hours' sleep, and sometimes in a shorter time, there is formed in the body a sufficient amount of these substances to produce a little explosion in the muscles every now and then. These cause the limbs to twitch; the man becomes restless, rolls over in his sleep, and finally wakens, as the result of the stimulation of these poisonous substances.

Take for example the chronic invalid; he does not work because he has not strength enough. The sleep-producing substances naturally formed by exercise are lacking. So, when he goes to bed, he has the "fidgets"—he keeps twisting and turning about; because he has no sleep-producing substances in his body. Instead, his body is full of the poisons which accumulate during idleness, and the influence of these is irritating and exciting to the nerves. The man is uneasy, his brain is excited, he keeps thinking, he cannot stop thinking. His legs twitch and jerk, he cannot find a comfortable position; he lies first on one side and then on the other; he cannot be quiet long enough to go to sleep.

What is to be done for sleeplessness? In the first place, we must recognize the physiological facts in order to understand physiological treatment. We must not simply inquire "What will put a man to sleep?" There are many things that will do this. Bromide of potash, opium, alcohol, chloroform, or ether will put men to sleep; but the sleep they produce is not of the most restful sort, and one must always reckon with the after results.

What we want to do for the man who cannot sleep is to put him in a condition favorable to sleep—a condition in which he can sleep physiologically and naturally; and the way to accomplish this is to remove the cause of the sleeplessness. Here is a man who has broken his leg; he is accustomed to sound sleep, because he has worked hard and has earned the right to sleep. But now he cannot sleep because he cannot exercise. To produce natural sleep we must give him exercise. Some simple passive movements, such as bending the limbs, serves the purpose well, when greater activity is impossible.

There is really no excuse for anyone being sedentary. A man said to me not long ago, "I cannot take exercise for any length of time; I am a student, and I have no time for exercise." But the man who is sitting at his desk can take exercise, if he will, without interfering with work. By simply extending the arm and holding it perfectly steady, the muscles are given some work to do, and after about two minutes the arm will be so tired that it cannot stay in that position any longer. Drop both arms at the sides, and energize every muscle, straighten out all the fingers, make them stiff, and hold them so; or, bend one leg up close to the body, make it rigid, and hold it in that position, and you will be astonished to see how tired you will become.

One can put all his energy into one set of muscles in trying to set the limb in motion, and all his energy into another set of muscles in trying to hold it still. This is just as hard work as it is to lift a heavy weight. One can make his muscles work just as hard in this kind of exercise as in ordinary work by putting one set of muscles in opposition to another set, as the flexors in opposition to the extensors of the arm. Set the muscles absolutely rigid, hold them so, and in five minutes one will be perspiring profusely. A large number of movements of the head, limbs and trunk can be made by the bedridden invalid, by which the benefits of good, hard exercise may be secured. All this work, the sedentary invalid can do for himself.

If one is able, he should work two or three hours before going to bed. Ericsson, the great inventor,

* Good Health.

made it a habit of his life to go out two hours before he went to bed, no matter whether the evening was pleasant or stormy. This practice kept his brain active, because it secured refreshing sleep. William Cullen Bryant, the poet, the literary man, and the editor, for forty years before his death took systematic and vigorous exercise every day of his life. He took exercise the first thing on arising in the morning, and the last thing before going to bed. He walked from eight to ten miles daily, never using street cars, coaches, or elevators, so as to get the benefits and blessings of work. Too many persons do not have the resolution to do this.

METHOD OF ASCERTAINING BY MEANS OF A DYNAMOMETER CAR THE POWER REQUIRED TO OPERATE THE TRAINS OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD BETWEEN MOTT HAVEN JUNCTION AND GRAND CENTRAL STATION, AND THE RELATIVE COST OF OPERATION BY STEAM AND ELECTRICITY.*

By BION J. ARNOLD.

IN August, 1901, the writer was commissioned by the New York Central Railroad Company to study the conditions governing the operation of its trains between Mott Haven Junction and Grand Central Station, and to report upon the feasibility of operating them by electricity. This division consists of 5.3 miles of four-track road forming the trunk line, or main artery over which the trains from the three divisions of the New York Central and the main line of the New York, New Haven & Hartford Railroads enter the city of New York. For 2.[illegible] miles from Mott Haven Junction the tracks are carried on an elevated stone and steel structure; then for 2.04 miles through a tunnel underneath the street, emerging into an open cut .68 of a mile long, then terminating at the Grand Central Station in an intricate stub-end yard, having about eight miles of switching tracks. Over this division are made nearly 600 train movements per day, as almost all trains entering the yard or station must be returned to Mott Haven Junction, owing to lack of sufficient storage tracks at the Grand Central terminus.

The annoyance to passengers due to the use of steam locomotives in the tunnel, caused the company to examine into the advisability of adopting electricity, and it is through the courtesy of Mr. W. J. Wilgus, chief engineer of the company, under whose directions the investigation was made, that the writer is allowed to present to this Institute the technical substance of this report.

* Paper read at the 19th Annual Convention of the American Institute of Electrical Engineers.

All money values relating to total cost of installation, real estate, etc., and many other elements upon which the final recommendations of the report were based, together with many of the general recommendations and conclusions themselves, are necessarily omitted from this paper, but it is believed that the data given is sufficiently complete to enable one to check the technical conclusions herein given.

Soon after taking up the work it became evident, on account of the number and weights of the trains to be handled and the numerous variable elements entering into the operating system, which would not adapt themselves conveniently to formulæ, that the most practical and satisfactory way of ascertaining the power required to propel the trains was to measure, by means of a dynamometer car, the "draw-bar pull" of a sufficient number of trains of various weights, to determine the average power required per train and from this compute the general load diagram.

A dynamometer car known as "Test Car No. 17," owned jointly by the Illinois Central Railway Company and the University of Illinois, was secured, and men thoroughly skilled in its use were employed to operate it. This car was coupled between the engine and the train in each case, and operated on trains running over the different divisions of the road, so that not less than four runs, two or more in each direction, were made for each class of train. Since the trains of all divisions, including those of the New York, New Haven & Hartford Railroad, run over the New York Central tracks between Mott Haven Junction and Grand Central Station, the records of the New York Central trains for this division will apply to trains of equal weight on the New York, New Haven & Hartford road, and were so considered in the calculations.

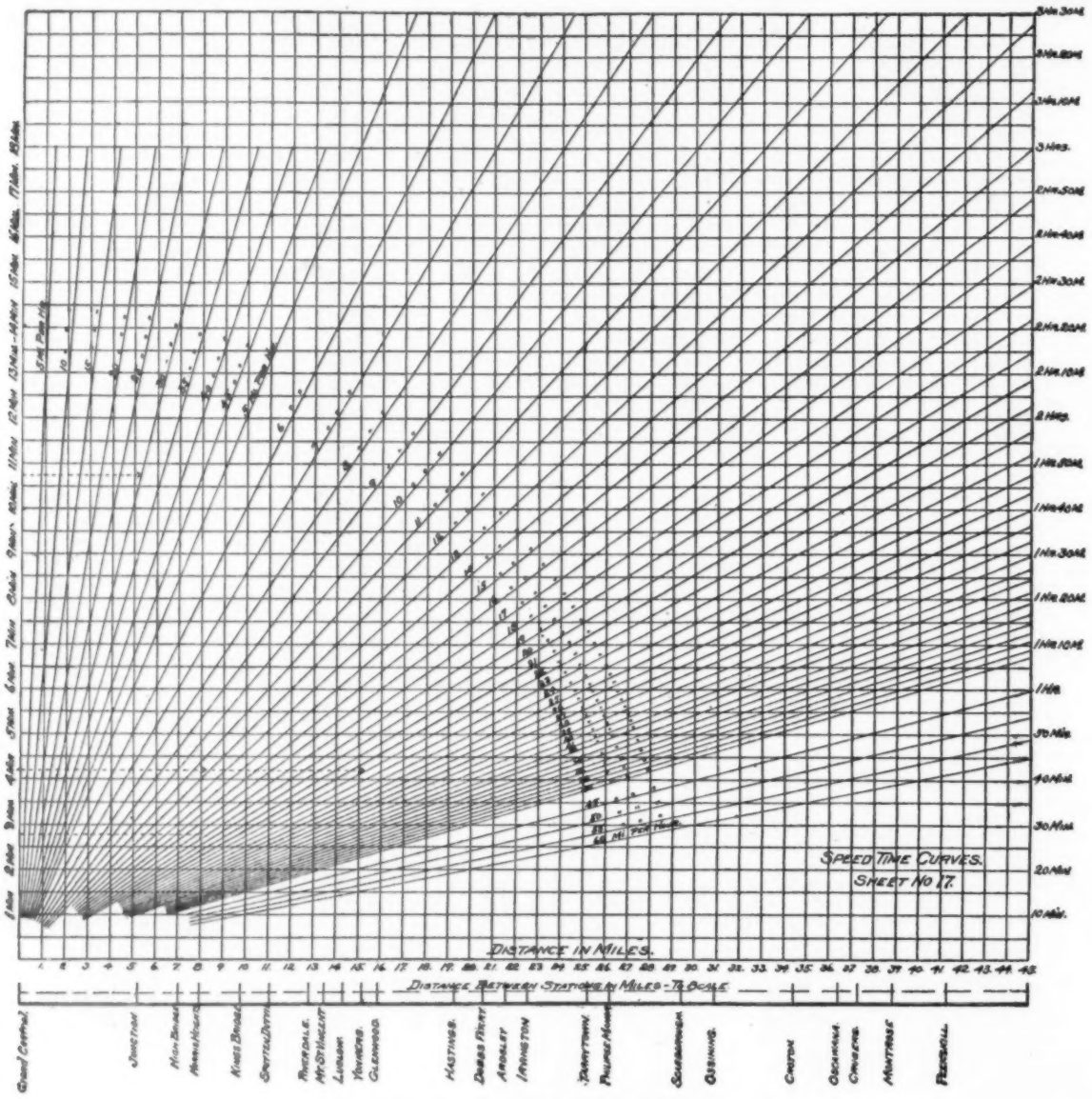


FIG. 17.—SPEED TIME CURVES.

Description of Dynamometer Car.—In the dynamometer car employed, the draw-bar is secured by means of a suitable rod to a piston head which fits closely in a cylinder filled with oil. The pull at the draw-bar thereby produces a pressure upon this oil which is transmitted through suitable piping to the recording device, consisting essentially of a Bourdon gage, which by means of a suitable arm and pen records upon paper, driven past it by gearing from the car axle, in such a manner that the height of the record from the base line is proportionate to the draw-bar pull. This base line, and time and position lines, are produced by separate pens, the former recording every five seconds by means of clock-work, and the latter recording at mile posts, stations, etc., when an electric circuit is closed by hand. The other instruments in use on the car during these tests were a Boyer speed recorder, an anemometer for recording the relative velocity of the wind, and a weather vane showing the direction of the wind relative to the direction of travel of the car.

The dynamometer cylinders are made of three castings held together by stud bolts. The effective area of the largest cylinder is 60 square inches, of the intermediate cylinder 30 square inches, and of the smallest 5 square inches. It is intended that the working pressure of the oil in the cylinder shall be from 300 to 1,000 pounds, per square inch, and for this range of pressure the largest cylinder has sufficient capacity for the heaviest freight service, the intermediate cylinder would be used when working with a train of ordinary tonnage, and the smallest cylinder when working with a train of light tonnage. If it should become necessary all the cylinders could be coupled up in multiple, thus giving an effective piston area of 95 square inches.

The cylinders are reamed and the pistons and piston rods ground. The forward end of the gland is ground spherical and fits into spherically ground seat in the stuffing box casting. This spherical seat is used to permit the three sleeves to align themselves properly on the rod. The pressure of the oil keeps the gland on its seat and this oil pressure is supplemented by the pressure of several helical springs placed between the rear end of the sleeve and the plate at the inner end of the stuffing box. The pistons will gradually move forward on account of leakage, but so slowly that the cylinders can be refilled from the pump at stops, or if necessary, when the cylinders are under pressure. This design was resorted to in order to avoid the uncertainty concerning the frictional resistance incident to the use of the usual packed pistons and stuffing boxes.

The questions of changes in the Grand Central terminal, or of the present method of train operation, or of handling the suburban trains on the division outside of Mott Haven Junction are not considered in this paper.

It appears that the braking effort per ton is not as high on certain types of locomotives as it is on coaches. This is due to the fact that not all of the wheels of the locomotive are always braked, and those that are braked cannot be set to the skidding point with a fully loaded tender, for if they were they would then skid with a lightly loaded tender. Hence the draw-bar pull during retardation is often as great, or even greater than it is during acceleration.

METHOD OF OBTAINING HORSE POWER AT DRAW-BAR FROM DYNAMOMETER RECORDS.

This was obtained in general in the following manner: From actual dynamometer car tests the average draw-bar pull of the various trains over the various runs was determined, proper allowance made for increased train weight due to motor equipment, and finally a reduction of the draw-bar pull thus obtained to horse-power, and eventually to kilowatts. Owing to the fact that the maximum speeds on this division seldom exceed 35 miles per hour and that the trains were never less than three cars in length—often reach-

ing eleven cars in length—no correction was made for head end air resistance.

The successive steps were as follows:

(1) In order to determine the average draw-bar pull for any given period, the entire area under the dynamometer pen record was found by a planimeter and divided by the length of base of the interval from start to stop, the result being the average draw-bar pull.

(2) From passenger records taken during dynamometer tests, a curve was plotted, showing the ratio of the weight of the live load to the light weight of the train.

(3) Dividing the average pull in pounds by the total weight of the train, the average pound per ton draw-bar pull over the run under consideration was obtained.

The average pounds per ton draw-bar pull (not tractive effort) for various lengths of run over the Mott Haven division were also plotted.

The number of variables entering into values obtained, such for example as the degree of skill of the engineer, the wind velocity, the condition of the track, agreement with schedule time, etc., make it impossible for any curve to pass through all its points and therefore, as above stated, these curves can only be taken as indicating the average value of a widely varying quantity.

(4) Fig. 17 shows a graphical method of obtaining the speed in miles per hour between any two stations when the time of run between these two stations is given. If the lower strip of this diagram be cut off along the dotted line and placed horizontally at the left with any station on the ordinate at the given time, the intersection of any other station with an oblique line gives the average speed between these stations.

For example, if the run from the Grand Central Station to Yonkers is made in 42 minutes, by placing "Grand Central Station" on the ordinate at the left at 42 minutes and running horizontally along the strip to "Yonkers," the oblique line here intersected shows the average speed to be 22 miles per hour; in the same manner, if the run from Grand Central Station to Mott Haven Junction is made in 10¼ minutes, the average speed is thirty miles per hour. Again, by placing "Spuyten Duyvil" on the ordinate at the left at 28 minutes, and following horizontally to "Hastings," the average speed between these two stations is seen to be 18 miles per hour.

(5) The weight of every train arriving or leaving the Grand Central Station on a given day was obtained, and its average speed between stops determined from the above curves. Knowing, therefore, the average draw-bar pull in pounds required to haul a train, and the average speed at which this draw-bar pull was exerted, the horse power at the draw-bar becomes:

H. P. = foot pounds per minute/33,000
= draw bar pull × miles per hour × 5,280/33,000 × 60
= draw bar pull × miles per hour/375.

This formula is represented graphically in Fig. 18, from which, knowing the draw-bar pull and speed, the horse power or kilowatts corresponding thereto is determined. Thus, for example, if the draw-bar pull is 4,300 pounds, at a speed of 36 miles per hour, to find the horse power or kilowatts corresponding thereto. At 4300 pounds, on the ordinate at the left of the figure, follow the dotted line to the right until it intersects the required speed curve, thence downward to the base line thus obtaining 410 horse power. If the efficiency of the motor is taken at 70 per cent, by following the ordinate at 410 horse power vertically to the 70 per cent curve and thence to the left, the kilowatt capacity required is found to be 440 kilowatts, which is the power required to propel the train, exclusive of the locomotive and head-end resistance.

METHOD OF OBTAINING DAILY LOAD DIAGRAM.

From a careful examination of the weights of all locomotives now in service on this division, it was found that properly powered electric locomotives having a total weight of 65 tons each, all of which would be available for tractive effort, could satisfactorily perform the service of existing steam locomotives.

This horse power was obtained in the same manner as that required to haul the train, and was plotted separately on the train sheets; evidently, the friction of an electric locomotive in pounds per ton is greater than an equivalent weight of train, but this difference was considered in selecting the proper locomotive efficiency.

The average horse power when converted into kilowatts by means of the following formula (which is exhibited graphically in Fig. 18):

k.w. = h.p. × 746/70 per cent × 1,000

where 1,000 watts = 1 k.w.

746 watts = 1 electrical h.p.

and 70 per cent = efficiency of locomotives

gives the average kilowatt input required at contact shoes of electrical locomotives for the period covered by each sheet.

In another instance it is shown that the daily average input required would be at the rate of 1,800 kilowatts and, therefore, the total annual input required at the contact shoes of the locomotives, for propulsion alone, would be 1,800 × 24 × 365 = 15,768,000 kilowatt hours. From the total number of tons hauled yearly over this division, including passenger, shop trains and switching service, the ton-miles per year were found to be 250,285,710. Hence, the electrical energy required to haul a ton one mile over this division under the existing conditions would be

15,768,000,000/250,285,710 = 63 watt hours per ton mile.

With this figure as a basis and the load factor as determined from the load diagram, the problem of determining the best method of producing, distributing and applying the power was considered.

CHOICE OF SYSTEM.

While it is the writer's opinion that the alternating current railway motor will yet prove to be the most efficient, all things considered, for long-distance railway work, it has not yet in his opinion demonstrated its ability to start under load as efficiently or to accelerate a train as rapidly as the direct current motor. The line under immediate consideration was short, the trains numerous and rapid acceleration desirable, all of which are conditions favorable to the direct current motor.

Furthermore, direct current motors with their necessary auxiliaries have become fairly well standardized and it is the only class of electric railway apparatus available from the manufacturers of the United States without involving experimental work and large development expense.

In view of these facts and the probable necessity for rapid construction, the writer refrained from advising anything of an experimental nature and, therefore, recommended the direct current system in combination with the third rail for the main line, and the overhead construction for the yards, all of which have demonstrated fully their ability to meet the conditions imposed by railway operation so far as motive power is concerned, although there has not yet been an electric installation on any existing terminal that is as complex, or into which anywhere near the number of heavy trains enter as on this section of road.

Had the length of road under consideration been considerably greater, and had it been thought possible to secure sufficient time to conduct experiments or invite demonstrations by manufacturers of alternating current motor equipment, this class of apparatus would have been more seriously considered.

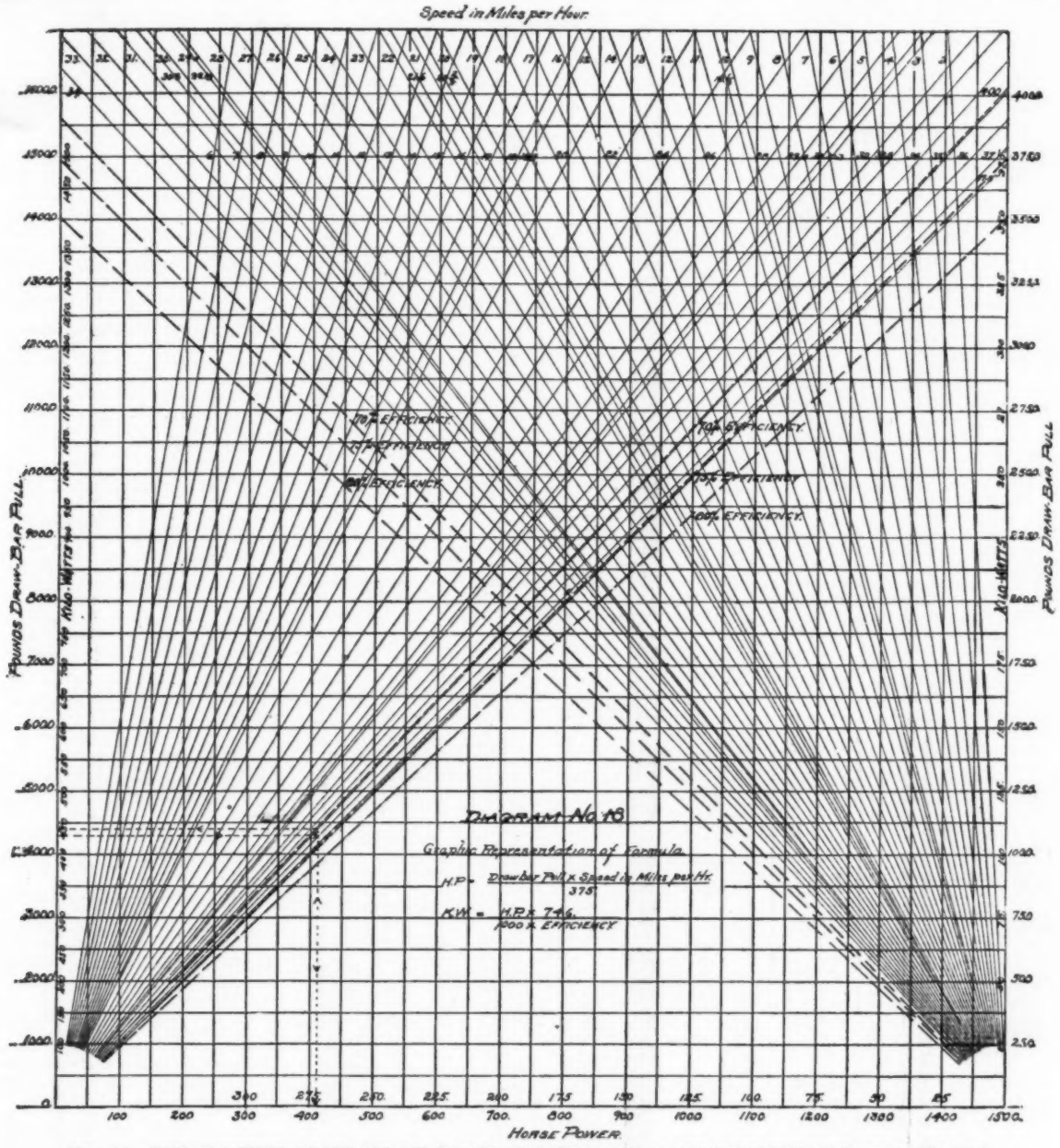


FIG. 18.—DESCRIPTIVE DIAGRAM OF DRAW-BAR PULL IN HORSE POWER AND KILOWATTS.

DISCUSSIONS AND ANALYSIS OF PLANS AND ESTIMATES.

In the preparation of estimates, twelve distinct plans of generation and distribution were considered and the results tabulated as shown in Table 4. All the estimates were computed upon the same basis so far as cost of fuel, labor and losses in transmission were concerned. The different headings in the table

TABLE IV.—Table of Estimates on Plans for Proposed Electrical Equipment of the N. Y. C. & H. R. R. R. Between Grand Central Station and Mott Haven Junction.

Plan.	CHARACTER OF STATIONS ETC.	E = Total k.w. hours at power house	F = Total k.w. hours at contact shoe	G = Total k.w. hrs. at motor terminals	$J = \frac{B}{I}$	$K = \frac{C}{I}$	$L = (J + K)$
1.	Direct current power station at center of line and contiguous to tracks. 600 volt working conductor, no batteries	.447c	.60c	1.06c	14.02c	6.58c	20.60c
2.	Same as No. 1, with batteries in power house	.472	.66	1.137	14.65	6.71	21.36
3.	Same as No. 1, with battery substation near Grand Central Station and Mott Haven Junction	.475	.668	1.20	14.7	7.25	21.95
4.	Alternating current power station on river front near center of line, with rotary converter substations near each end of line. 11,000 volt A. C. and 600 volt D. C.	.572	.715	1.287	15.2	7.58	22.78
5.	Combined D. C. and A. C. Power station at Harlem River near one end of line and one rotary converter substation near the other end of line. 11,000 volt A. C., 600 volt D. C., no batteries	.570	.666	1.19	14.7	7.18	21.88
6.	Direct current feeders from Manhattan Railway substation located near center of line. Transmission from substation to working conductor, 600 volts D. C. energy to be purchased	2.5	.650	2.748	34.64	2.89	37.53
7.	Rotary converter substation at center of line. A. C. energy to be purchased from Manhattan Substation and transmitted at 11,000 volts. Energy to cost ½ cent less per k.w. hour than D. C. energy delivered	2.5	2.336	2.508	31.50	4.23	35.73
8.	Two rotary converter substations, one near each end of line. A. C. current to be purchased from Manhattan substation near center of line	2.1	2.336	2.504	31.50	3.93	35.43
9.	Combined A. C. and D. C. power station near Harlem River at end of line. One substation near other end, and batteries carried on locomotives charged from working conductor	.519	.629	1.122	16.58	7.76	24.34
10.	One rotary converter substation near center of line, A. C. current purchased from Manhattan substation No. 7, batteries on locomotives charged from working conductor	2.12	2.4	2.502	34.40	4.08	38.48
11.	Direct current feeders from Manhattan substation No. 7, near center of line. Batteries on locomotives charged from working conductors	2.5	2.738	2.742	37.81	2.51	40.32
12.	Combined A. C. and D. C. power station at Harlem River near outer end of line. One substation near other end. Batteries in power station and substation. A. C. transmission 11,000 volts, D. C. conductors 600 volts	.55	.775	1.335	15.80	7.83	23.63

A. C. refers to alternating current. D. C. refers to direct current.

here shown are deduced from another table not here published, the columns of which were as follows:

Column A.—Total Cost of Entire Installation.—Erected complete, consisting of power house, transmission circuits, feeders, sub-stations, track construction chargeable to electrical equipment, overhead construction and electric locomotives.

Column B.—Total Operating Expenses per Annum.—Including wages in power house and sub-stations and on rolling stock, together with all coal, oil, water, waste, repairs, etc.

Column C.—Fixed Charges per Annum.—Including interest at 4 per cent on total investment, and taxes at 2 per cent on buildings, sites, machinery and electric locomotives.

Column D.—Total Expense per Annum.—Made up of Column B plus Column C.

Column E.—Operating Expenses per Annum at Power House.—Including coal, water, oil, waste, etc., and repairs and wages.

Column F.—Operating Expenses per Annum at Contact Shoe.—Including coal, water, oil, waste, etc., and repairs and wages in power house; oil, waste, repairs and wages in sub-stations; and repairs (labor and material) on transmission lines.

Column G.—Total Expense per Annum Exclusive of Rolling Stock.—Including operating expenses per annum at contact shoe (as in preceding Column F) plus fixed charges as follows: interest at 4 per cent on total investment (less cost of electric locomotives) and taxes at 2 per cent on buildings, sites and machinery.

Column I.—Total Locomotive Miles per Annum.—Determined from information furnished through the Operating Department.

The explanation of the columns in Table 4 is as follows:

Column H is:

$$\frac{\text{Column E (of table not published)}}{\text{Total k.w. hours generated at P. H.,}}$$

and represents the operating expenses per kilowatt hour at power house switchboard.

Column M is:

$$\frac{\text{Column F (of table not published)}}{\text{Total k.w. hours delivered to contact shoe, annually,}}$$

and represents the operating expenses per kilowatt hour at contact shoe.

Column N is:

$$\frac{\text{Column G (of table not published)}}{\text{Total k.w. hours delivered to motor terminals annually,}}$$

and represents the *total cost per kilowatt hour delivered to motor terminals, exclusive of fixed and operating charges on electric locomotives.*

The cost per kilowatt hour at motor terminals differs from the cost per kilowatt hour at the contact shoe only when batteries are carried on the locomotives, in which event the cost per kilowatt hour at the motor terminals is increased over the cost per kilowatt hour at the contact shoe by the cost of energy lost in the batteries.

Column J is:

$$\frac{\text{Column B (of table not published)}}{\text{Column I}}$$

and represents the operating expenses per electric locomotive mile. The values in this column are directly comparable with values now obtained in the present steam locomotive service, except that the operating expenses for steam locomotives as shown by the performance sheets of the Motive Power Department do not include any charge for water. From the best information available, the cost for water for the present service on this division is about .987 cent per locomotive mile, which amount added to the present cost as shown on the locomotive performance sheets, gives an amount which should be compared with the values of Column J.

Column K is:

$$\frac{\text{Column C (of table not published)}}{\text{Column I}}$$

and represents the fixed charges per electric locomotive mile, and is here tabulated merely as a step in obtaining

Column L (which is Column J plus Column K) and represents the *total cost per electric locomotive mile.*

While the results in Column L of Table 4 indicate that Plan No. 1 was the most advisable one to adopt, it was not seriously considered for the reason that it necessitated locating the power station in a part of the city where its erection would probably have been prohibited by the city authorities, but it was here introduced for comparison as indicative of the economy to be gained by placing the power station at the theoretical center of distribution. The same objections apply to Plans 2 and 3.

Plans 4 and 5 bring out quite clearly the difference in the cost of operation between two sub-stations and one, both plans permitting the location of the power station on the river front.

The difference in favor of Plan 5 is entirely due to the saving in labor of one sub-station.

Plans 6, 7 and 8 were studied with the object of ascertaining whether the purchase, instead of the generation of power, would offer a satisfactory solution of the problem.

The purchase of both D. C. and A. C. energy was considered on the lowest basis that it was thought possible for any existing company to furnish it, and it was found that the D. C. energy would cost the railroad company one-half cent more per kilowatt hour than the A. C. energy, in consequence of the interest, depreciation, maintenance, etc., of the transmission lines, rotary converters and other sub-station apparatus which would have to be furnished by the energy-producing company.

The prohibitive annual cost of these purchasing plans is at once observed by reference to Columns L and M, the plans only meriting consideration as representing a temporary arrangement that might be effected in order to allow rapid installation.

Owing to the more or less complex system of overhead or third rail yard construction made necessary by the nature of the case, and the advantages to be obtained by their elimination in the substitution of locomotives which could, for switching service, be self contained, though normally supplied with energy from the working conductors, a study was made of electric locomotives carrying batteries.

The results of these studies made under several different assumptions are shown under Plans 9, 10 and 11. From Columns L and N it is evident that whatever may be gained by the elimination of the overhead construction is largely offset by the additional cost of operation, although it will be observed that the cost per locomotive mile of Plan 9 compares favorably with the cost of Plan 12.

Plan 12 differed only from Plan 5 in a slight reduction in the capacity of the converting apparatus in the power house and sub-stations and the substitution therefor of two storage batteries (one located in or near the power house and one in the sub-station) each of such capacity that it, together with only a portion of the main station and sub-station machinery, would be capable of taking over the entire load of the line for a short period of time in cases of emergency.

The additional first cost and the slight increase in annual expense (as compared with Plan 5) represented by a reserve station capacity of this nature, was thought to be of secondary importance only, in view of the increased reliability of operation thereby obtained. The increased cost of operation in this plan over that of Plan 5 is due to the fact that the battery maintenance was figured at 10 per cent per annum, which is considerably higher than is ordinarily assumed, and will probably be considered excessive by some.

A battery of this kind would not only serve as a reserve but would prove of considerable value as a regulator of potential along the line, and in addition it would, notwithstanding its inherent losses, tend to reduce the power house operating costs by taking up the excessive load fluctuations of the system and permitting the load upon the engines to be maintained at or near their most efficient working capacity.

It was considered of the utmost importance in an installation of this magnitude that the number of interruptions of power supply be reduced to a minimum, that no device which could increase the safety and reliability of the plant should be omitted, and that the probability of future extensions of the electrical system should be considered. As best fulfilling the above conditions, therefore, Plan 12 was the one specifically recommended for adoption.

OPERATING EXPENSES.

A careful compilation of all the expenses entering into the operation of the present steam service was made and the following comparative table (Table 5) of relative costs is believed to be correct, assuming that the present locomotives running between Mott Haven Junction and Grand Central Station should be abandoned and the service now performed by them duplicated by electric locomotives operated in accordance with Plan 12. It is assumed that the electric locomotives will be operated by the same class of men as those who now operate the steam locomotives and that they would receive the same rate of pay that they now receive.

This condition is not favorable to electric traction as it is not ordinarily necessary to have two men to operate an electric motor, but in the writer's judgment, it is not advisable to operate a service of this class under such exacting conditions without two men on each locomotive.

If the motor car system should be adopted, as it probably would be were the electrical equipment extended beyond Mott Haven Junction, or if the forward guard or brakeman were allowed to take the place of the second man while passing through the tunnel and yards, a saving equivalent to his wages could thereby be effected.

With two men of the same skill as at present employed on the locomotives, the figures are as follows:

TABLE V.

	Steam.	Electricity.
Operating expenses per locomotive mile exclusive of fixed charges but including water, labor, cost of cleaning and repairing tunnel, and all other expenses of locomotive operation	23.05	15.80
Fixed charges per locomotive mile assuming that it now requires 40 locomotives to perform the present service and that 33 electric locomotives could perform the same service	1.13	7.83
Total in cents	24.18	23.63

From these figures it appears that while there would be a slight annual saving in operating expenses in favor of electricity, it is not sufficient to warrant its adoption on the grounds of economy in operation alone, although its adoption can be justified on other grounds.

These figures could be made more favorable to electricity were an optimistic view of many of its advantages taken, and the probability is that practical operation will show a somewhat greater gain than here indicated, but it has been deemed best by the writer to maintain a conservative view throughout the entire investigation.

It is, however, safe to conclude that the saving in operation expenses by the electric system would be sufficient to offset the increased fixed charges due to the additional investment made necessary by its adoption.

The dynamometer car was operated by Edward C. Schmidt, Professor of Railway Mechanical Engineering of the University of Illinois. He was assisted by Messrs. J. J. Snodgrass and R. W. Lohmann.

Messrs. B. S. Harrison, Hugh Hazleton, R. W. Lohmann, J. J. Snodgrass, H. A. Strauss, and A. S. Courtright, assisted in the calculations and preparation of the report.

In connection with the investigation, a series of Comparative Acceleration Tests of Steam Locomotives and Electrical Equipment were made at Schenectady, the results of which are set forth in another paper prepared by Mr. W. B. Potter and the writer, which is to be read at this meeting.

ACETYLENE SOLVENTS.

M. ED. FOUCHE, of the Compagnie Francaise de l'Acetylene dissous, has related to the French Physical Society the results of his experiments carried out during the past four years with acetylene, and its various solvents. The result of his researches shows that the best solvent for acetylene is acetone. This substance has a boiling point not less than 133 deg. Fahr., and is an excellent absorbent of the gas, one volume at 59 deg. Fahr. absorbing 24 volumes of acetylene at atmospheric pressure. The specific gravity of the solution is 0.71 at 48 deg. Fahr., that of liquid acetylene being 0.42. The solution has a coefficient of expansion only about one-fifth of that of the liquid acetylene. He found also that the presence of water in the acetone seriously retarded its absorbing power. Therefore, in order to obtain the most satisfactory results it is essential that as pure a solvent as is commercially obtainable should be utilized, and the acetylene should itself be thoroughly dried before passing it into solution. The latter cannot be exploded so long as the pressure of the dissolved gas is less than 140 pounds per square inch, but at double this pressure the whole mass can be detonated. By absorbing the acetylene in a porous medium no apprehension need be entertained of the solution exploding. Neither will it escape except by evaporation, even if the containing vessel be broken. The company with which M. Fouché is connected have adopted as an absorbent a special porous brick having a specific gravity of 0.5 and having 80 per cent of voids, experience with which has proved so satisfactory that the French authorities have, under certain conditions, legalized the manufacture and transport of the solution thus absorbed, in steel cylinders, or bottles, similar to those used for the carriage of compressed gases. The standard sizes have a water capacity equal to .071 cubic feet, .423 cubic feet and 3.53

cubic feet respectively, and hold one hundred times the volume quoted of acetylene at the standard pressure of one hundred and forty-two pounds per square inch. With a suitable incandescent burner, M. Fouché states that a light of 475 candle power can be obtained with a consumption of .01 cubic feet of acetylene per hour, at a pressure of 12 inches of water. Compared with ordinary compressed gas, as used for railroad car lighting, dissolved acetylene only requires one-fiftieth the volume per candle hour of lighting supplied. One pound weight of receiver will contain dissolved acetylene equivalent to 50 candle hours, using incandescent burners, and about 23 candle hours with ordinary burners.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Commercial Travelers in the Orient.—The experience of two young Americans who recently spent six months traveling through Japan, China, and the Philippines for the purpose of soliciting trade, affords good evidence that there is much commerce to be secured by Americans if it is properly sought. These young men studied the Chinese language in San Francisco and acquired a sufficient knowledge of it to make themselves understood. They had therefore, the great advantage of being able to do business directly with their Chinese customers. As it was their first trip in the Orient, they did not bring a large variety of samples, but the results have been so encouraging that they propose to return equipped with an enlarged outfit. The method pursued by these young men is worthy the attention of our manufacturers. If two young Americans can learn the language in San Francisco sufficiently to enable them to deal with the Chinese in their own country, others can do the same.

I have received a letter from the salesmen who made this experimental trip during the past year, in which they tell of what they have accomplished. In speaking of cotton piece goods, they refer to the market in southern China. The letter, which may be of interest to American manufacturers looking for trade in the Orient, reads:

As we did not know exactly what class of goods of American manufacture the market here required, we came to make a test, and brought with us the following lines: American watches, rings, lockets, collar and cuff buttons, watch chains, electrical supplies, clocks, cotton piece goods, etc., all of which we pushed to the utmost.

Watches.—Notwithstanding the fact that at present Swiss watches have the greatest sale, with those of French make a close second, we had no difficulty in obtaining good orders, even though our prices were a trifle higher than those asked for European goods.

Watch Chains.—In this line, we found trade very good, our only drawback being that we did not have the patterns desired, although the prices asked were satisfactory. If we had had the patterns desired, in the quality of our samples, our orders would have been trebled.

Jewelry.—In the general lines of jewelry, rings, etc., we had a very good trade and we found a fair demand for American plated jewelry of all descriptions.

Clocks.—Our line of clocks is a low-priced one, but even so our prices could not compare with those asked for clocks of Japanese make; therefore we could not compete.

Electrical Goods.—We had an excellent trade in electrical supplies, and found the Chinese ready buyers of American goods.

Cotton Piece Goods.—We regret exceedingly to report that owing to the lack of enterprise shown by our manufacturers at home in not attempting to cater to the wants of this market regarding widths, lengths and qualities desired, we were unable to obtain any business from the Chinese, for the reason that the qualities were too fine and the prices too high for the market. In fact, for some of our goods the prices we were expected to get were double those asked by our European competitors for products of an equal grade. We will add that we found the Chinese very much interested in American cotton goods, and, were it not for the handicaps above stated, America would to-day be getting her share of the piece-goods trade in this market.

Soliciting Trade.—The trade solicitor employed by commission houses throughout China is a being known as the "market shroff," who, as a rule, performs the combined duties of a salesman and collector. As a general thing, his only qualification for filling the position is that he can carry on a conversation in "pidgin English." Judging from the standpoint of an American, he is a rank failure as a salesman. As an illustration, we will state that on our arrival in Shanghai, it was our intention to go after the trade with the assistance of a "shroff" who was recommended to us, but after showing him our samples and being informed by him that they were not suitable for the market, we decided that this was only his opinion, and that we would go from shop to shop with our samples and satisfy ourselves. This we did, with the result that on the goods which the shroff condemned we met with great success. We also find that the fact that we speak the Chinese language has had great weight with the merchants.

Payments.—All our bills sold were paid on the letter-of-credit basis.

Prospects for Future Business.—In our opinion there is a splendid opening in China for American-made goods and we are now hurrying home, armed with samples of goods, together with the prices at which they sold in the Chinese market, and copious notes regarding classes of goods in which the United States is not represented in this field, which we hope to induce our home people to manufacture.—W. A. Rublee, Consul-General at Hong Kong.

Some German Opinions of Borax for Preserving Meat.—On May 9 an important convention was held at Berlin by a number of scientific men, to enter a protest against the enforcement of the new law prohibiting the use of borax and boracic acid in preserving meats and other food articles, which law is to take effect next fall and will practically prohibit the importation of a large quantity of American preserved meats into Germany. The leading spokesman in this convention was Prof. Dr. Liebreich of Berlin, one of the ablest pharmacologists of this country, who took strong ground against the new law. He admitted that if it were possible to use all our food articles in their natural condition without changing them or adding to them, as strict hygienists instst we should, it would be an ideal situation; but he maintained that it is an impossible one. Scientific investigation and practical experiments had shown that the reasons urged by the Bundesrath for promulgating the new meat-inspection law were entirely untenable, and he insisted that before any governmental department should declare articles of food to be injurious to health and dangerous to human life it should use the greatest care in making sure that its information and its conclusions were indisputably correct. And he further averred that the only safe way of reaching conclusions on this subject was through experiments made with the preserving chemical upon the human system; therefore, he would not consider experiments made with animals, for many animals were entirely proof against certain poisons, while others were sensitive to things that had a harmless effect upon man.

He strongly advocated the use of borax, but emphasized its proper use, reminding his audience that the immoderate use of pepper and mustard is also injurious to health. He argued that it would be a bad practice to prohibit the use of foods to people generally, simply because they might not be good for children and invalids; otherwise it would be necessary to prohibit by law the use of sauerkraut and pork. It would have been more reasonable, he declared, to have officially stated exactly what quantities of boracic acid are injurious, and the meat packers would have been governed accordingly.

Others speakers in the convention continued in the same strain, contending the utter harmlessness of borax upon the mucous membrane of the stomach and intestines. One of them called attention to the fact that the British government, after careful and extensive investigation, had recently announced that it saw no reason for prohibiting the use of boracic means of preserving food articles.

Dr. Gerlach, of Wiesbaden, declared that boracic acid had been in use for decades among civilized nations as a means of preserving, and there had been ample time for showing definitely any evil effects, but no complaints had been heard from the people, and this new law came without any warning.

Finally, the convention unanimously adopted the resolution that "the prohibition of borax and boracic acid for the preservation of food articles, as decided upon by the Bundesrath, is not to be justified and cannot be supported by facts."—Henry W. Diederich, Consul at Bremen.

Trust Movements in Austria-Hungary.—Oil.—Negotiations are under way between oil refiners and raw-oil producers of this empire to regulate production in the interest of greater profits. It is proposed to limit output and divide the markets among the parties concerned. Both refiners and producers already have separate agreements. The present movement, therefore, has in view a combination on a broader scale—substantially a fusion of separate combinations.

Glass.—The agreement between Bohemian and Bavarian raw-glass producers formed for the purpose of regulating selling prices, which was dissolved some time ago, is to be at once renewed. In conjunction therewith, a former combination of looking-glass manufacturers of Bohemia and Bavaria is to be revivified. In both cases, the object is to reduce competition to a minimum and restore prices to a profitable basis.

Cement.—A union of Austrian Portland cement manufacturers has been effected. It is complained, however, that the recalcitrance of a few outside firms makes it very difficult to accomplish the purpose of the combination—to check a further fall in prices by judiciously dividing the markets among the parties to the agreement. But it is hoped that the outsiders may be gradually forced into line, as they come to realize that their interests are thereby subserved.

Iron.—After a severe struggle of two years, the iron industries of Austria and Hungary have formed a combination with the object of increasing profits by reducing competition and raising prices; though it is openly charged that the large concerns have all along been realizing dividends ranging from 7 to 25 per cent.

Previous combinations of iron industries have been formed in this empire, but they embraced only certain establishments or related to only a certain kind of product. But all these have been dissolved through disagreements or otherwise, and are succeeded by the present giant combination, which absorbs substantially every iron-working concern in the empire and covers every variety of iron product.

The agreement is to last ten years. During that period, a new iron-working establishment cannot be started in the empire—unless, indeed, it is able to use its own raw material, which will be practically impossible. All the iron smelters in Austria are owned by the members of the combination, and it is not practicable to start new ones. In Hungary, under peculiarly favorable conditions, some strata of iron ore might be developed outside of the trust, but enormous capital would be required. Thus, from appearances, the trust is in a position to absolutely shut out competition.

The liberal policy of the Hungarian government, in financially encouraging new industries, would seem to be an obstacle to trade combinations, but it is argued that this policy really aids the iron combination, since its protective spirit leads to legislation tending to exclude foreign competition.

In production and in markets, the iron industries of this empire have gained much during the past decade. Certain individual works have largely increased their working capital, and others have added materially to their producing capacity.

The markets will be carefully divided among the members of the combination. In one respect, the Hungarian members have secured a decided advantage over their Austrian brethren. Under the agreement the former may deliver to Austria 280,000 metric centners (28,000 tons of 2,204.6 pounds) of product, while the latter may deliver only 110,000 metric centners (11,000 tons) to Hungary. Under former agreements the exchange was equal.

In to-day's newspapers it is announced that members of the combination have notified their customers that they cannot make future contracts at the old prices. The increases, it is stated, range from 1 to 4 crowns (20 to 80 cents) per 100 kilogrammes (220.46 pounds), depending upon the kind and quality of the iron product.—Frank W. Mahin, Consul at Reichenberg.

Trade Openings in Harbin, Manchuria—Fire Insurance.—I enclose a letter concerning fire insurance that I hope will attract the attention of home companies.

The writers also desire to enter into arrangements to export pig bristles and hemp-seed oil to the United States and wish correspondence in these lines.

In this connection, I would urge upon American exporters the importance of establishing an agency in Dalny with a branch at Harbin and at other places in Manchuria. This is one of the richest sections of the world in agricultural and mineral resources; it has a large trade in many lines and its commerce promises to increase enormously.

Harbin is growing very fast and is now a city covering three towns within an area of four miles diameter, with a Russian population of about 12,000. It is on the navigable section of the River Sungari, at the junction of the Chinese Eastern and Manchurian branches of the Siberian Railroad, and is headquarters for three divisions of the road. Many goods from the United States are now marketed there and many more can be, and it is quite important that our trade interests should be represented at an early day by American citizens, before lines of goods from other countries have become established in the market.

I would most earnestly advise American firms to join in establishing an agency at Dalny or Port Arthur with a branch at Harbin. This could be done to especial advantage by Pacific coast firms. The business interests of the United States are losing an excellent opportunity by not having permanent agencies in Manchuria. Trade in many lines can be opened by these agencies without the necessity, to begin with, of carrying stocks here. Agencies should be under the management of Russian-speaking citizens of the United States.—Henry B. Miller Consul at Niuchwang.

(Inclosure.)

HARBIN, April 9 (22), 1902.

To the Consul of the United States of America, Niuchwang, China.

SIR: Referring to our conversation, we beg to draw your attention to the fact that there could be done a good business in the line of fire insurance, as the rates paid (2 to 2.5 per cent) are rather high, and only Russian companies are as yet represented here.

We should be very pleased if you could induce any American company to open a branch here like those already opened at Port Arthur, and we offer our services as agents.

Harbin has two well-organized fire brigades, and there would be no more risk than in any other town in China.

Yours, faithfully,

HAGEMEYER & LUTTERMANN.

Commercial Traveler Tax in Jamaica.—Commercial Agent N. R. Snyder of Port Antonio, under date of May 27, 1902, reports that an act abolishing the tax of £22 10s. ($109.49) on commercial travelers dealing in spirits and of £12 10s. ($60.90) on those not dealing in spirits was passed in the last session of the legislative council, and received the assent of the governor. During the existence of this law, adds Mr. Snyder, many salesmen arrived in the island intending to transact business, but, owing to what they considered an excessive tax for a stay of a week or fortnight, they left without selling any of their wares.

Ice Machinery and Refrigerators in Germany.—According to German papers, the mild winter has caused a scarcity of ice and has led the brewers' society to investigate ice machinery. This would open a wide field in Germany, which should be taken advantage of by American manufacturers; but this work must be done by active American salesmen and not left in the hands of local German houses. It is best, also, to patent all goods in Germany before placing them on the market, to prevent imitations and infringements.

There is also a good opening for American ice boxes in this country, especially in the small, cheap kind. A couple of years ago, a large New York house sent a quantity of ice boxes and chests to the Leipzig fair, where they created quite a sensation. They sold well, and the prospects for trade were excellent; but the house made the mistake of putting its goods into the hands of a firm in another city, which understood nothing of the handling or use of ice boxes. As a result, no business was done. Germans who have seen the up-to-date ice boxes at this consulate have asked where we got them, their cost, etc., and have signified their desire to buy.—Oliver J. D. Hughes, Consul-General at Coburg.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1368. June 16.—*Trade Openings in Harbin, Manchuria; Fire Insurance—Proposed Law Affecting Insurance Companies in Chile—Improvement of Roads near Athens—*Ice Machinery and Refrigerators in Germany—*Demand for Scales in the Transvaal.

No. 1369. June 17.—*Some German Opinions of Borax for Preserving Meats—Sewerage Improvements in Bremen—German Trade in Tool Machinery—Granting of Patents in Germany—Trade between Nicaragua, Guatemala and Salvador—Russian Petroleum in Greece.

No. 1370. June 18.—Trade Condition in Sergipe, Brazil.

No. 1371. June 19.—*Trust Movements in Austria-Hungary—Prize for Method of Drying Potatoes—A Novel Employment of Rafia Fiber.

No. 1372. June 20.—*American Shoe Stores in Germany—*American Shoes in Bohemia—Meat and Cattle Trade in Barcelona—International Maritime Congress at Copenhagen—Code of Signals for Brazilian Vessels—German Charges on Trunks of Traveling Salesmen.

No. 1373. June 21.—German Chambers of Commerce and Commercial Education.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Lacquer for Metal—Quick Drying and Hard.—The following has been recommended very highly as being "easily applied, sticking to anything from paper to metal and glass, drying quickly and being very hard"—which about fills the list of virtues desired:

Rosin, amber	8 parts
Benzin, 0.710 s. g.	14 parts
Linseed oil varnish	3 parts
Turpentine, thick	1 part

Add the rosin to the varnish and heat until they are dissolved and a homogeneous mixture has been secured, then remove from the fire, let each down to about 80 to 85 deg. F., and add and stir in the turpentine and benzol. If too thick add benzin as needed. For fear that the former, which is a French formula, may not prove satisfactory, we add the following, also said to be universal in application:

Shellac	60 parts
Copal, Manila	60 parts
Mastic	60 parts
Venice turpentine	15 parts
Alcohol, wood	1,000 parts
Glass, coarsely powdered, sufficient.	

Mix and set aside for from 10 to 14 days, giving it frequent shakings daily. When solution has taken place add one part of boric acid and filter. The article is now ready for use, and may be employed on woods, paper, metal, etc.—National Druggist.

Safety Envelope Paste.—

A.

Chromic acid	2½ parts
Stronger ammonia	15 parts
Sulphuric acid	½ part
Cuprammonium solution	30 parts
Fine white paper	4 parts

B.

Isinglass, a sufficient quantity.	
Acetic acid	1 part
Water	7 parts

Dissolve sufficient isinglass in the mixture of acetic acid and water to make a thin mucilage.

One of the solutions is applied to the surface of the envelope and the other to the flap. The parts are then fastened together, when the union is so firm as to resist acids, alcohol, hot or cold water and steam. The chromic acid forms with the isinglass a combination insoluble in water.—Drug. Circ.

Pepsin Chewing Gum.—The following formula for a base is as good as any:

Gum chicle	56 parts
Paraffin, hard	15 parts
Tolu balsam	2 parts
Peru balsam	2 parts
Sugar, fine granulated	160 parts
Glucose	64 parts
Water, sufficient.	

Macerate the chicle in water until it is saturated, or has taken up all the water it will absorb. Strain off superfluous water, put the gum in a capsule of sufficient size, add the paraffin and balsams and melt together. Mix the sugar and glucose with 50 parts of water and boil together until a little of it brought out on the end of a rod, dipped quickly into a glass of cold water and instantly withdrawn, will snap between the fingers on an attempt to bend it (the "crack" point, or eighth degree, of sugar boilers and confectioners). When this is reached quickly remove from the source of heat, pour out and spread on a slab of sufficient size, previously greased with butter or good sweet oil. As soon as the syrup is spread add to it, a little at a time, carefully working in as you do so, the mixture of gums and paraffin until the mass has acquired the proper degree of toughness, which must be learned by experience, as no rule can be given therefor. The flavoring matter (essential oils of various sorts to the taste) and the ingredient, pepsin in this instance, should be added to the mixture of gums before incorporating with the candy. All this reads and sounds easy enough, but before you get through with the job you will find that experience here, as in every trade, is the prime requisite of success.—National Druggist.

Repairing Enameled Letters.—Copal and dammar, each 5 parts are mixed with 4 parts of turpentine and enough alcohol incorporated to form a thick liquid after standing for several weeks. Six parts of zinc oxide (white) is then added and well mixed in. When desired for use some of the mixture is heated, and when most of the alcohol has been driven out, is applied to the crack and smoothed off while warm. When cool, the cement is polished by rubbing.—Drug. Circ.

Red Varnish or Paint for Magnets.—

Shellac, bleached	4 parts
Venice turpentine	2 parts
Cinnabar, powdered	3 parts
Alcohol, sufficient to dissolve.	

Melt the shellac and turpentine together, remove from fire, let cool down to about 140 deg. F., then stir in 10 parts of alcohol. Rub up the cinnabar with sufficient alcohol to make a paste, add it to the turpentine and shellac mixture and put the whole on the water-bath for a few minutes, under constant stirring. When quite fluid and homogeneous withdraw from the bath and let cool, stirring all the time. Preserve in well-stoppered vessels, and when required for use place the container in the water-bath and warm until the contents become sufficiently fluid to be applied with a brush.—National Druggist.

Jasmine Soap.—

White soap	50 kilos
Jasmine essence	300 grammes
Oil of African geranium	60 grammes
Oil of petit grain	50 grammes
Oil of lignaloe	45 grammes
Oil of ylang-ylang	45 grammes
Heliotropin	5 grammes
Nerolin	2 grammes

—Drug. Circ.

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